Towards a Constructionist Theory of Musically-Induced Emotions

Julian Céspedes-Guevara

Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Department of Music

The University of Sheffield
June 2016

Abstract

Listening to music can arouse a variety of affective responses. The study of this phenomenon has flourished during the last two decades, particularly thanks to the contribution of the BRECVEMA theory and the Multifactorial Process Model. Nevertheless, these theoretical frameworks have adopted a psychological reductionist approach that neglects the symbolic dimension of music, and the effect of situational factors. The first aim of this thesis is to overcome these shortcomings by proposing a theory based on contemporary constructionist theories of emotion. This novel theory proposes that listening to music activates automatic perceptual mechanisms that produce fluctuations of affect, and that the activation of associative and appraisal mechanisms transform the fluctuations of affect into a variety of emotional and nonemotional responses. The second aim was to test some of the hypotheses derived from this framework. The first experiment tests the prediction that listening to music while engaging in motor rhythmic entrainment leads to fluctuations of valence and arousal. Although the results did not support the hypothesis, they suggest that the phenomena of rhythmic entrainment, musical expectancy, and motor planning arise from shared perceptual principles. The second and third experiments investigate the phenomenon of emotional contagion with music. The results suggest that embodied simulation does not contribute significantly to listeners' affective reactions, and that semantic knowledge activated by the music, by personal associations, and by extra-musical information biases the type of perceived and induced emotions experienced by the listeners. The third aim of the thesis was to explore alternative ways of measuring musically-induced emotions. Two indirect techniques are implemented and evaluated, and a novel questionnaire of subjective experiences is developed. The main conclusion of the thesis is that the constructionist theory here proposed constitutes a fruitful approach, as it provides a non-reductionist heuristic framework that produces new hypotheses for future investigation.

Acknowledgements

This thesis was made possible by the financial support of a scholarship from the University of Sheffield, and a scholarship from Colciencias (Colombia). My dream of carrying out doctoral studies in the United Kingdom would not have been possible without their endorsement.

I am also immensely grateful to my supervisor, Professor Nikki Dibben, for her guidance and encouragement, for giving me the liberty to try my ideas, and for helping me to gain confidence as a researcher. I am also grateful to my second supervisor, Tom Cochrane, for the challenging discussions and feedback he offered me during the first stage of the thesis; and to Maria Witek, for generously providing me a copy of her stimuli for my first experiment.

Special thanks to all the people who volunteered to participate in my experiments. Particularly, the kind people from the Lindy Hop dancing scene in Sheffield: thank you for participating in the studies, thank you for bringing your friends and relatives along, and most of all, thank you for all the dances and good times that helped me keep my mental sanity while making the thesis!

I also thank my family, for their support, and for being so proud of me. *Gracias especiales a mis padres: soy lo que soy, y estoy donde estoy, por ustedes.*

Last but not least, to Laura, *mi dulce compañía*, for offering me her loving support throughout these years, in spite of my mood swings. You fill my life with happiness. *Te dedico esta tesis a ti, y a nuestro futuro, mi amor.*

Contents

List of tables

List of figures

1. Introduction: aims and object of study

Listening to music can arouse a wide variety of affective experiences. At times, listening to music helps us evoke emotional experiences from the past (F.S. Barrett *et al.*, 2010), at other times, music helps us focus on the present situation (Diaz, 2011; Lamont, 2011). Music can facilitate feeling more connected to other people (Boer *et al.*, 2011), and it can relieve our feelings of loneliness when we listen to it on our own (Van den Tol & Edwards, 2014). Music can motivate us to move along to it (Witek, Clarke, Wallentin, Kringelbach, & Vuust, 2014), or to adopt an attitude of still and quiet contemplation (DeNora, 2000). Listening to music can elicit positive feelings of calm and joy, and have positive effects on our mental and physical health (Papinczak, Dingle, Stoyanov, Hides, & Zelenko, 2015), but it can also arouse negative feelings such as grief, irritation, anxiety and boredom (Sloboda, O'Neill, & Ivaldi, 2001). Sometimes these emotional experiences with music can be so striking that we can remember them for years (Gabrielsson, 2001). Many other times, by contrast, these experiences are fleeting and unmemorable, and sometimes barely accessible to consciousness. Moreover, even people for whom music plays a central role in their identity have had the experience that at times, listening to a favourite piece of music can transform their mood, while at other times, it leaves them indifferent.

During the last two decades, this power of music to move us emotionally has received increasing interest from researchers, as demonstrated by the publication of two editions of the seminal edited book *Music and Emotion* (Juslin & Sloboda, 2001, 2010a), the organisation of four specialised conferences about this topic, and the publication of more than 250 research articles addressing this phenomenon (in the period between 1998 and 2009) (Eerola & Vuoskoski, 2013). However, it is fair to say that while this wave of scientific interest has advanced our understanding of musical emotions, the importance that music has in our lives is not exhausted by its emotional dimension. Across cultures all over the world music is part of cultural events fulfilling functions and acquiring meanings that are not necessarily emotional (Clarke, 2014).

What is it about music that can evoke such a wide variety of emotional and non-emotional experiences? The paradigmatic example that almost every psychological theory of emotion has used to explain how emotions are elicited is the experience of fear provoked by suddenly encountering a bear in the woods. According to this account, the evaluation of the event as threatening triggers the emotional response with its associated physiological, behavioural, and motivational components. This paradigmatic explanation (which, incidentally, does not apply to many other emotional experiences in everyday life), is inadequate to answer the question about how music arouses emotional and non-emotional experiences. Listening to musical sounds does not seem to have any immediate consequence for our survival or for the realisation of our goals. And clearly, the construction of culturally-relative meanings in music cannot be accounted for by the activation of automatic survival mechanisms. Hence, it is apparent that traditional psychological approaches to emotion cannot fully explain musical emotions.

Several theories have embraced the challenge of providing explanations that circumvent the problem of the apparent irrelevance of music for the realisation of goals (e.g. Colling & Thompson, 2013; Davies, 2013; Huron, 2006; Meyer, 1956). And in the last years, two groups of investigators have proposed theoretical frameworks that integrate several causal mechanisms: Juslin and collaborators' BRECVEMA theory (Juslin, 2013a; Juslin, Liljeström, & Västfjäll, 2010; Juslin & Västfjäll, 2008), and Scherer and colleagues' Multifactorial Process Model (Scherer, 2004; Scherer & Coutinho, 2013; Scherer & Zentner, 2001). These two theories coincide in the assumption that musically-induced emotions emerge from the interaction of factors in the music, the individual, and the situation (Juslin *et al.*, 2010, p. 607; Scherer & Zentner, 2001, p. 365). However, as I demonstrate in the first three chapters of this thesis, the approach taken by these theories is still based on the notion that emotions are produced thanks to the activation of mechanisms in the individual's mind that process music as mere acoustic stimulus. Consequently, these theories neglect the symbolic dimension of music, and find it difficult to account for the wide variety of emotional and non-emotional experiences with music outlined above.

The **first aim** of this thesis is to overcome these shortcomings by proposing an alternative theory based on the principles of constructionist theories of emotion, exemplified by Lisa Feldman Barett's Conceptual Act Theory (Barrett, 2006b, 2011, 2012). This type of theory adopts a non-psychological reductionist approach, and therefore, their principles can be adapted to explain how the listener's bodily and affective state is influenced by factors such as the musical structure, the meaning of the situation, the symbolic connotations of the music, and extra-musical information, producing a variety of emotional and non-emotional responses. To my knowledge, this is the first time anyone has attempted to produce a full account of musically-induced emotions using the principles of constructionist theories.

The **second aim** of the thesis is to test some of the empirical predictions derived from this new theoretical framework. To this end, I carried out three experimental studies, all related to the predictions that listening to music induces overt and covert embodied responses, that these embodied response produce changes in our underlying affective tone, and that these changes can become discrete emotional experiences influenced by semantic associations.

The **third aim** of the thesis is to explore alternative techniques for measuring musically-induced emotions. Based on the constructionist principles introduced in the theoretical chapters, I adapted two techniques that indirectly detect the presence of subtle affective responses in the participants, and developed a new questionnaire that taps into previously unexplored dimensions of emotional responses.

In the first part of this chapter, based on a short review of the main psychological theoretical traditions in the study of emotions, I propose a consensual definition of emotion that guides the theoretical and empirical work carried out in the thesis. In the second part, I review evidence that suggests that music can induce a variety of affective states, and I present three essential questions that a theory of induction of emotions by music should answer.

1.1 What are emotions?

More than a hundred years after James' foundational attempt to define the term "emotion" (1884), affective scientists still find it difficult to reach an agreement on how to conceptualize this construct (Beck, 2015; Kleinginna & Kleinginna, 1981; Russell, 2012; Scarantino, 2012; Scherer, 2005). This lack of consensus stems from the roots that every emotion theory has in different philosophical and psychological traditions. These epistemological differences have led each theory to focus on different aspects of emotional phenomena, and to use different premises and constructs to explain them, as I explain below.

There are several ways to classify psychological theories of emotion according to different criteria (e.g. Gross & Barrett, 2011; Moors, 2009; Scherer, 2000). Here I organize them into four groups according to their historical origins and the main assumptions they share:

Basic-Emotions theories. This tradition was inspired by Darwin's investigation into the similarity of expression of emotions in animals and humans (1872), and was later elaborated as a psychological theory by Tomkins (1962, 1963), Izard (1977) and Ekman (1992). The basic premise of this tradition is that human emotions have developed in evolution to fulfil fundamental adaptive functions, and are organised into discrete affect programs with distinctive expressive, behavioural, and neurophysiological patterns.

Jamesian, Somatic, Perceptual, or Psychological Constructionist theories. This theoretical tradition has roots in the work of James (1884), who proposed that emotions are not organised into naturally-predetermined types, but emerge when we feel the bodily changes that occur after the perception of an exciting stimulus (James, 1884, pp. 189–190). This emphasis on the interaction between perception of bodily feelings and contextual information is still the central assumption present in all the theories within this approach (Barrett, 2006b; J. J. Prinz, 2004; Russell, 2003; Schachter & Singer, 1962). – A notable exception is Damasio's theory, according to which emotions occur thanks to the re-activation of neural patterns that represent bodily states as if they were actually happening. This theory is also different from the rest in that it proposes that the resulting emotions correspond to basic emotions (Damasio, 1994).

Social constructionist theories. These theories are inspired by sociological theories such as Berger and Luckmann's (1966) and by the culturalist approach to cognitive development proposed by Vygotsky (1978). For these theories, emotions are determined by the sociocultural context in which they occur, and are considered as culturally-prescribed performances that regulate and constrain the roles that individuals have in a given social context (e.g. Averill, 1980; Boiger & Mesquita, 2012; Harré, 1986).

Appraisal theories. This tradition started with the work of Arnold (1960), who proposed that emotions are caused by processes of cognitive evaluation of the meaning of a stimulus. Although this premise is still central to contemporary appraisal theories, they vary in the number of appraisals they propose, and in the number and type of emotions that result from the process of evaluation (Lazarus, 1966; Moors, 2013; Roseman, Wiest, & Swartz, 1994; Scherer, 2009a; Smith & Ellsworth, 1985).

The different ways in these theories conceptualise their object of study entail other fundamental disagreements among them, as I summarise below.

1.1.1 Disagreement 1: The Process of Emotion Causation

Theories vary in the importance they have allocated to the question of how emotions are elicited, and therefore, they also differ in the level of detail they have provided about this process.

The main concern of researchers working in the Basic Emotion tradition has been to demonstrate the phylogenetic origin of emotions, and therefore, they have concentrated on finding evidence for the existence of universal expressions of emotion, not on explaining how emotions are aroused. Hence, these theories simply propose that emotions are triggered when we face the same fundamental life-tasks that our ancestors did during the evolution of the species (Ekman, 1992).

For the Social Constructionist approach, the question of how emotions are caused is also secondary. For these theories, having an emotional response depends on learning a socially-prescribed script that determines how to interpret situations, how to display the emotional state, and how to label it. Consequently, researchers in this approach have been less concerned with the mental and bodily aspects of emotion, and have focused instead on finding evidence for cultural and historical differences in people's emotional vocabulary (e.g. Harré, 1986; Hurtado de Mendoza, Fernández-Dols, Parrott, & Carrera, 2010).

The question about emotion causation is more important for the Jamesian or Constructionist approach, where the focus has been on explaining the nature of the subjective feelings that are essential to emotional experiences. Since this tradition explains emotions as emerging from the interaction of proprioceptive feelings of bodily changes and contextual information, researchers in this tradition have attempted to demonstrate how different contextual situations produce a variety of emotional responses (e.g. Carroll & Russell, 1996; Lindquist & Barrett, 2008; Schachter & Singer, 1962).

The Appraisal theories tradition considers the elicitation question as crucial. For these theories, emotions are triggered when we encounter a stimulus or situation that we evaluate as relevant for our goals and well-being. Hence, investigators within this paradigm have concentrated on identifying the dimensions in which stimuli are appraised, and the effects of those appraisals on different aspects of emotional responses (e.g. Bossuyt, Moors, & De Houwer, 2014; Ellsworth & Smith, 1988; Scherer, 2009b).

1.1.2 Disagreement 2: The Relationship between Emotional Categories

Most theoretical traditions share the assumption that emotions are “continuous and continuously varying phenomena” (Frijda, 2008, p. 73), instead of psychologically or biologically discrete events (Barrett, 2006; Harré, 1986; Russell, 2003; Scherer, 2009a). This premise has three implications. First, there is a potentially infinite number of emotional categories (Scherer, 2009b). Second, the difference between an emotion category and another is a matter of degree. And third, the boundaries between emotions and other affective states categories depend on linguistic and conceptual distinctions, rather than on biological ones (Fugate & Barrett, 2014; Lindquist, Barrett, Bliss-Moreau, & Russell, 2006).

For the Basic Emotion tradition, by contrast, emotions are essentially discrete phenomena. The central claim of these theories is that each fundamental “basic” emotion is associated with biologically distinctive sub-systems, and forms the basis of all other emotions.[1]

---

[1] I provide a more detailed and critical review of the claims of Basic Emotion theories in Chapter 3.

1.1.3 Disagreement 3: Affective Dimensions

All theories coincide in that emotions can be described by using at least two dimensions: valence and activation. *Valence* consists in the degree to which an experience, a stimulus, or situation, is experienced as pleasant/unpleasant, good/bad, appetitive/aversive, etc. *Activation* or *arousal*, in turn, refers to the degree of mobilization or energy involved in any affective reaction (Russell & Barrett, 1999). From a physiological point of view, arousal refers to the level of excitation of the autonomic nervous system, whereas from a subjective point of view, it refers to the felt intensity of the emotional response (Mulligan & Scherer, 2012).

Some theorists have proposed to further distinguish the arousal dimension as constituted by two components: *energetic arousal*, which consists of the degree of experienced wakefulness (ranging from feeling sleepy to feeling awake), and *tense arousal*, which consists of the degree of experienced mental stress (ranging from feeling calm to feeling nervous) (Schimmack & Rainer, 2002; Thayer, 1989). Furthermore, based on analyses of linguistic categories, several authors have proposed a third emotional dimension, consisting of the degree of experienced control or power that we have over the eliciting situation, and that ranges from feelings of weakness, submission or vulnerability, to feelings of strength, domination and power (Fontaine, Scherer, Roesch, & Ellsworth, 2007; Osgood, May, & Miron, 1975).

Despite this relative consensus around the concepts of valence and arousal, a further disagreement between theories is that some researchers consider these affective dimensions mere conceptual characterisations (e.g. Ekman, 1992; Mulligan & Scherer, 2012), whereas others regard them as the fundamental psychological and physiological building blocks of all affects (e.g. Russell, 2003).

1.1.4 Disagreement 4: The Components of Emotions

An analysis of the empirical strategies used in affective science shows that independently of their theoretical paradigm, all researchers have explicitly or implicitly acknowledged that emotions are made up of several components, and consequently they have investigated them by measuring one or several of these components at a time. Thus, researchers have studied the *feeling component* of emotions (by asking people to report how they feel), the *motor or expressive component* (by observing the facial, vocal, and postural changes associated with emotional states), the *somatic component* (by studying patterns of neural activity and physiological changes), the *cognitive component* (e.g. by examining the way people evaluate the situation that elicits the emotional response), and the *motivational component* (by exploring the urges or impulses that people experience when they undergo an emotion).

It is possible to find points of disagreement in this point, too. Emotion theories vary in the number of components they include, and the relative importance that they allocate to them (Moors, 2009). For instance, Basic Emotion theories regard the motor-expressive component of emotions as the most informative one (e.g. Matsumoto & Willingham, 2009), whereas Appraisal theories consider the cognitive component as the essential one (e.g. Moors, 2013).

1.2 A consensual definition

Despite the diverse panorama presented so far, I do not draw from it the pessimistic conclusion that it is not possible to reach accord about the definition of emotion in the near future. Indeed, a review of the definitions proposed by authors as varied as Scherer (Mulligan & Scherer, 2012; Scherer, 2005), Moors (2009), Frijda (2008), Juslin & Sloboda (2010b), Clore & Ortony (2013), Cunningham *et al.* (Cunningham, Dunfield, & Stillman, 2013), and Barrett (2014), yields several points of agreement that can be summarized as follows:

> Emotions are reactions of short duration to events or objects that are valued as relevant for the person’s well-being, goals, and/or personal values. This evaluation of an object or event as good/bad, pleasant/unpleasant, attractive/repulsive, moral/immoral, etc. occurs in several subsystems or components which tend to become synchronized. The components involved in emotional episodes (can) include: a *cognitive component* (i.e. appraisals of the meaning of the event, situation or object), a *somatic component* (i.e. central and peripheral neurophysiological changes), a *motor component* (i.e. expressive behaviour), a *motivational component* (i.e. action tendencies, urges, or states of action readiness), and a *feeling component* (i.e. the subjective emotional experience).

In this thesis, I adopt this consensual definition of emotion as the starting point for building operational definitions, and for establishing conceptual boundaries between emotions proper, and other related affective states:

1. This definition implies that states that are not clearly **valenced** (i.e. experienced as good or bad) are *not* emotions. Thus, it excludes affective states such as interest, expectation, and surprise (at least during the first few seconds of this reaction), or physiological states such as heightened arousal.

2. The presence of changes in **a single component in isolation** cannot be taken as sign of the presence of an emotional episode. This means that the mere presence of behaviours (such as tapping a foot), of facial expressions (such as smiling or frowning), of evaluations (such as judgements about the beauty of a musical piece), of motivations (such as an urge to dance), or of physiological changes (such as chills) should not be considered, by themselves, as indicators of emotional states.

3. **Feelings**, the subjective experience of having an emotion, constitute only one of the components of emotion, albeit a very important one. It can be argued that learning about this subjective aspect of people's emotional experiences can provide us with information about how the person construes the current situation that we cannot access with any other measurement technique. However, feelings are not exclusive to emotions: other affective states, such as moods and preferences are also "felt", and even non-emotional states such as curiosity, physical pain, and hunger involve subjective feelings. Therefore, asking people to report how they feel is useful, but at the same time, it does not provide us with sufficient information to establish that they are undergoing an emotional episode.

4. Emotions can be distinguished from **moods** in that emotions are intentional (i.e. they are directed towards objects or events which are perceived as causes of the reaction). Also, emotions are more intense, and of shorter duration than moods.

5. **Attitudes** are beliefs and predispositions towards objects or people (Scherer, 2005, p. 703). This implies that while attitudes can predispose a person to have certain emotional reactions, emotional reactions are always situated reactions, and therefore involve specific objects or events that are experienced as present or imminent in a specific context.

6. **Preferences** are more basic affective reactions than emotions. Preferences are simply evaluative judgments of stimuli in terms of liking or disliking, and of

predilection over another stimulus. Preferences are associated with basic approaching/avoiding tendencies (Scherer, 2005, p. 703).

7. There are other affective states that are not as diffuse and long-lasting as moods, but at the same time, are less discrete and object-focused than full-blown emotions. Several authors have proposed slightly different conceptual categories to describe them:

    - Ortony, Norman and Revelle (2005) distinguish between *proto-affect*, *primitive emotions*, and *emotions*. Proto-affects consist of basic approach and avoidance responses. Primitive emotions comprise automatic responses to present or expected events, and include awareness (but not self-awareness). Emotions consist of cognitively elaborated states of affective feeling, experienced as discrete states with a cause.

    - Baumeister, Vohs, DeWall, and Zhang (2007) distinguish between *automatic affect* and *emotions*. Automatic affects consist of fleeting automatic responses that are not more than a quick twinge of feeling that something is good or bad, or liking or disliking for something. These responses arise and dissipate quickly, involve very little cognitive elaboration, and drive behavioural responses. Emotions by contrast, consist of conscious reactions experienced as discrete states, that arise and dissipate slowly, result from appraisals, are experienced as saturated with cognitions, and do not directly drive behaviours.

    - Cunningham and Zelazo (2007) take a slightly different approach to distinguish affective states from one another: instead of talking of different categories, they suggest that the affective evaluation of an object takes place through an iterative sequence. The first iterations of this cycle occur exclusively within evolutionary primitive neural structures like the amygdala, but the subsequent iterations involve progressively cortical ones. The result of this process is that every iteration yields progressively richer and contextually meaningful representations. Evaluations based on few iterations are unconscious and automatic, whereas evaluations based on additional iterations become relatively reflective.

As can be seen from this brief summary, despite their differences, all these theories share the assumption that, besides the traditional distinction between moods and emotions, a complete description of affects should include basic responses characterised by being quick, automatic, unconscious, and by containing little cognitive elaboration.

8. The existence of these quick, automatic and primitive responses highlights the importance that **consciousness** has in distinguishing emotions from other affective states. Recent evidence has shown that presenting subliminal stimuli to participants can make them undergo *unconscious affective reactions*, as demonstrated by their subsequent evaluations of stimuli (Murphy & Zajonc, 1993), and by their behaviour (Winkielman, Berridge, & Wilbarger, 2005). However, the type of affective reactions demonstrated in these studies only amounts to *preferences*. That is, these affective reactions are no more than automatic evaluations about the "goodness" or "badness" of an object, which correlate with approach or avoidance behaviours. To my knowledge, no research so far has demonstrated this type of unconscious effect beyond this basic level (Schooler, Mrazek, Baird, & Winkielman, 2015).
9. In contrast, defining emotions as intense affective reactions to personally relevant objects and events implies that these affective reactions cannot be completely unconscious. In other words, emotions are always *felt*, they are experienced as part of the content of the individual's perceptual present, and therefore, they always involve first order awareness (Edelman, 2001). At the same time, however, this definition does not require emotions to involve self-reflective awareness or higher-order consciousness. In other words, having an emotional experience is independent of perceiving that one is undergoing that emotional reaction, and of labelling with an emotional adjective (e.g. "I am feeling sad", or "this music makes me happy").

Lambie and Marcel's theory (2002) about the role of consciousness in emotional experiences offers a useful classification that can further clarify this point. According to these authors, it is possible to have two types of emotional reactions depending on where the focus of attention is placed. In *world-focused emotions*, our attention is placed on the properties of the object or event, which we perceive as inviting or repulsive, moral or immoral, welcoming or threatening, etc. In *self-focused emotions*, we take a reflective attitude, and therefore our attention is placed on how we feel enhanced or diminished, powerful or weak, rightful or morally stained, etc. This distinction parallels Clarke's (2014) discussion about how music can also be experienced in different levels of consciousness, which do not always involve high-order consciousness.

From my point of view, embracing the consensual and restrictive definition of emotion proposed above has the advantage of defining the object of study that theories of musically-induced emotions should aim to explain. However, at the same time, there is also the risk of adopting a definition so restrictive that it excludes other important affective reactions that people experience with music and that may possibly be more common than emotional episodes. I dedicate the next section to discuss the extent to which music elicits a variety of affective states beyond emotions.

1.3 What type of affective reactions can music induce?

A recent review of studies on music and emotion (Eerola & Vuoskoski, 2013) found that more than half of the reviewed papers (53.49%) measured the participants' induced affective states by asking them to select one or more adjectives from a list. Most of these studies (75%) included basic emotions in their questionnaires (usually joy, sadness, and anger), frequently mixed with other adjectives considered to be relevant for musical experiences (e.g. peacefulness, solemnity, tenderness, distress and surprise) (p. 312). Other studies, in contrast, used ad-hoc lists of emotional adjectives constructed by the researchers, in many cases without clear theoretical basis – a situation that makes comparing the results from different studies very difficult. This methodological tendency to use self-report questionnaires of emotional adjectives suggests that the majority of researchers have implicitly or explicitly assumed that music generally induces a relatively small number of full-blown, discrete emotions. However, once we step out of the laboratory and study people's everyday experiences with music, we start to find that affective experiences with music are much more varied, and probably much less discrete than experimental research has assumed (c.f. Sloboda, 2010).

First, studies using in-depth interviews about uses of music in everyday life have found that people use music for a variety of functions, such as relaxing, passing the time, creating an atmosphere, accompanying other activities, and helping concentration (Greasley & Lamont, 2011). In many of these situations music seems to fulfil these functions at least in part thanks to the effects that it has on people's moods and emotional states (Sloboda & O'Neill, 2001). However, even though most participants in these studies display detailed knowledge about the type of music that they need to listen in every circumstance, they do not always choose to talk about these emotional effects in terms of specific emotions. Thus, in studies with adolescents, adults, and older people, many participants use eloquent but unspecific expressions such as music “creating an atmosphere”, helping them “release tension”, “lifting them up”, helping them “become energized”, or “having a better feeling” (Saarikallio & Erkkila, 2007); music getting them “going” or “in the mood”, making them “feel good”, “keeping their mind working” (DeNora, 2000); music making them feel “awake, thinking well, functioning well”, giving them “pleasure”; experiencing music as a “reflection”, “complement” or “extension” of themselves; and music “clarifying” their current mood (Hays & Minichiello, 2005).

A second line of enquiry that demonstrates the existence of a great diversity in affective experiences with music is Gabrielsson’s research into strong experiences with music (Gabrielsson, 2001). In his studies participants reported a variety of positive and negative feelings that go beyond basic emotions (e.g. gratitude, bliss, sexual feelings, pride, patriotism, jealousy, despair, worry, confusion, longing, etc.), and include mixed feelings (e.g. feeling tired and happy at the same time), quasi-physical reactions (e.g. feeling weightless, floating, carried away, charged, “out of the body”), and feelings that they could not describe with words (e.g. "it was an experience that goes far beyond my verbal and intellectual capacity, something I can only slightly touch with words") (Gabrielsson & Lindström, 2003, p. 170). Similarly, in a study using an open-ended questionnaire with music experts, Scherer, Zentner and Schacht (2002) found that participants perceived that music expresses and induces both discrete emotions and unspecific feelings, but they reported the later type more frequently.

This variety of types of affective responses is evident even in the results of two recent research programs that have tried to create standard questionnaires of musically-induced emotions. One of these projects has been carried out by Juslin and collaborators. In a series of studies using the Experience Sampling Method (ESM) and close-ended questionnaires they have identified what they consider to be the seven most frequently induced emotions (Juslin & Laukka, 2004; Juslin, Liljeström, Laukka, Västfjäll, & Lundqvist, 2011; Juslin, Liljeström, Västfjäll, Barradas, & Silva, 2008). An examination of this list makes it evident that some of these affective responses correspond to moods and other diffuse affective reactions, rather than to full-blown, discrete emotions, namely: calm-contentment, pleasure, interest and expectancy. (The remaining categories do correspond to discrete emotions: happiness, elation, nostalgia-longing, sadness-melancholy, and anger-irritation). The same conclusion can be reached by analysing the Geneva Music-Induced Affect Checklist (Coutinho & Scherer, 2015) developed at the University of Geneva as an update of their GEMS instrument (Zentner, Grandjean, & Scherer, 2008). Some of the factors they propose are better described as moods (and even as action tendencies) than as discrete emotions: relaxed-peaceful, powerful-strong, tense-nervous, moved-touched, energized-lively, and wanting to dance. (The other factors in this instrument consist of a mixture of everyday emotions and aesthetic evaluations: joyful, sad-melancholic, nostalgic-sentimental, feeling tenderness-affection, indifferent-bored, fascinated-captivated, filled with wonder-amazed, feeling transcendence-experiencing the sublime, feeling perfection-experiencing beauty).

Finally, the results of several recent studies on experiences with sad sounding music also show that far from being a single phenomenon, there are important sub-types of emotional experiences with this music: while some listeners undergo painful feelings of misery and grief, others become filled with bittersweet feelings of nostalgia, and yet others, experience mostly positive feelings of calm, relaxation and admiration of the music's beauty (Eerola, Peltola, & Vuoskoski, 2015; Garrido & Schubert, 2011; Van den Tol & Edwards, 2011). It is easy to see how these subtle but important variations in people's affective experiences with sad music would probably go "under the radar" of close-ended questionnaires which only include basic emotions as response options (e.g. sad, happy, angry, and scared).

Two conclusions can be drawn at this point. First, that the evidence from contemporary research indicates that people's affective experiences with music are varied, and do not always correspond to full-blown, discrete emotions. Second, that while the efforts for identifying frequently induced emotions and constructing standardised questionnaires have the advantage of increasing comparability among studies, they also entail the risk of narrowing the scope of research to a handful of discrete emotions deemed as more important or fundamental. In other words, there is the risk of becoming effectively "blind" to interesting and relevant affective phenomena by implicitly assuming that the emotions that *we can* manipulate and measure, are the *only ones* that music induces, or the only ones *worth* studying. In this sense, research into music-induced emotion runs the risk of making the same mistake that affective science has made through the years, where there is a great imbalance between the study of the so-called basic emotions and the rest of emotions in human experience.

1.4 What should a psychological theory of musically-induced emotions include?

In a review of philosophical and psychological theories of emotion causation, Moors (2009) proposes that ideally, an emotion theory should aim to address three types of questions or "problems":

The elicitation problem. A good theory should be able to explain which stimuli elicit an emotion, which do not, and how the organism determines this[2].

The intensity problem. A good theory should explain which stimuli elicit weak emotions, and which elicit strong ones; and what mechanisms determine these variations in intensity.

The differentiation problem. A good theory should explain which stimuli, mechanisms and representations determine the elicitation of positive vs. negative emotions, and which of these mechanisms determine the elicitation of specific emotions (anger, fear, sadness, joy, etc.)

I suggest that a theory of musically-induced emotions should also attempt to answer these questions. Moreover, in line with the evidence presented in the previous section, I submit that in the context of music, the intensity problem should also include a satisfying explanation of how and why people's affective experiences with music vary in a continuum that goes from mild, fleeting, unmemorable, world-focused affective reactions, to strong, long-lasting, memorable, self-focused emotional episodes.

My hope is that, by aiming to answer these questions, this ideal theory would not only be scientifically valid, but also relevant beyond the boundaries of the fields of music psychology and empirical musicology. From my point of view, a theory that manages to offer such a comprehensive account of musical affects would enable us, music psychologists, to dialogue with other disciplines such as music therapy, historical musicology, ethnomusicology, popular music studies, sociology of music, etc., where individual, historical, and sociocultural variability are essential.

---

[2] Research has estimated that music induces emotions in only about 55-65% of the music listening episodes (Sloboda & O'Neill, 2001).

1.5 Structure of the rest of the thesis

The rest of this thesis is structured as follows. In the next chapter, I present a critical review of the two most influential contemporary theories of induction of musical emotions: Juslin and colleagues' BRECVEMA (Juslin, 2013a; Juslin et al., 2010; Juslin & Västfjäll, 2008), and Scherer and colleagues' Multifactorial Process Model (Scherer, 2004; Scherer & Coutinho, 2013; Scherer & Zentner, 2001). I also argue that the most important limitation of these theories is that they have adopted a psychological reductionist approach, which neglects the social and symbolic dimensions of musical experiences, and the way these affective reactions emerge from the interaction of bodily, psychological, and situational factors. As part of this critical review, in chapters two and three I also present theoretical and empirical arguments to refute the claim, present in the BRECVEMA theory, that the activation of individual psychological mechanisms can lead to the induction of full-blown emotions. Chapter 3 in particular, examines the hypothesis proposed by that theory that emotions are induced via a process of emotional contagion. There, I criticise the assumption that this phenomenon occurs thanks to the existence of a shared acoustic code in vocalizations and music, which is organised around a set of basic emotions. I show the problems with the concept of basic emotions, and with the empirical evidence that proponents of the BRECVEMA theory have presented to support their claims, and I propose an alternative interpretation of that evidence.

In chapters four and five I present a theoretical proposal that aims to overcome the shortcomings I identified in contemporary theories of musical emotions. Chapter four describes the main theoretical assumptions shared by constructionist theories of emotion: the principle that emotions are situated affective states, the principle that emotions emerge from the interaction of systems that are not specific to emotions, and the principle that emotions have properties that are not evident in their components. I also dedicate that chapter to explain how these theories account for the process of emotion elicitation (emphasising Barrett's Conceptual Act Theory, 2006).

In chapter five I present a theoretical proposal that adapts these principles to explain the phenomena of musically-induced emotions. This theory suggests that when we listen to music, two types of mechanisms become activated, and that their interaction can lead to the emergence of a variety of emotional and non-emotional states. The first type of mechanisms consists of embodied perceptual processes that induce fluctuations in valence and arousal. The second type consists of a group of conceptual mechanisms that become activated by the music and the listening situation, and shape the fluctuations in core affect, producing the emergence of emotional and non-emotional responses.

Chapters six, seven, and eight present three empirical studies that test some of the hypotheses derived from my theoretical proposal. In general terms, these experiments test the claim that embodied processes of perceptual resonance produce fluctuations in core affect, and that the activation of associative mechanisms transform those fluctuations into a variety of emotional experiences. More specifically, the experiment in chapter six tests the hypothesis that listening to music while engaging in motor entrainment (as compared to listening without moving) leads to the induction of fluctuations in core affect. The experiment in chapter seven tests the hypothesis that processes of embodied simulation underlie emotional contagion with music. Chapter eight also tests this hypothesis by using a different method, and explores how these simulation mechanisms interact with associative processes activated by extra-musical information. Besides pursuing these theoretical aims, these experiments also involved the exploration of two indirect techniques for the measurement of musically-induced changes in affect, and the development of a novel questionnaire that measures the action tendencies, physical sensations, and appraisals that listeners experience while listening to the music.

Finally, in chapter nine, I evaluate the achievements and shortcoming of the thesis. I identify the strengths of my theoretical proposal, and its points of coincidence and difference with other contemporary theories of emotion elicitation. I also show how the findings of my empirical studies led me to rethink and revise some of the claims of my theory, and evaluate the advantages and disadvantages of the methodological strategies I adopted in those studies. Finally, I discuss the implications of my theory for future research.

2. Current theories of musically-induced emotions

Several theorists have proposed mechanisms to explain the induction of musical emotions. Meyer (1956) and Huron (2006) have proposed that the fulfilment, postponement or violation of expectancies evoked by music can lead to the induction of emotions. Davis (2013), Overy and Molnar- Szakacs (2009) and Cochrane (2010a) have proposed that listening to music can arouse emotional reactions in listeners thanks to the activation of emotional contagion mechanisms. Several authors have focused on how experiences of sensorimotor engagement with music (e.g. rhythmic entrainment) lead to affective reactions to music (Colling & Thompson, 2013; Trost & Vuilleumier, 2013; Witek *et al.* 2014). Instead of addressing all of these theories in detail, I concentrate the following critical review on the two perspectives that have integrated these and other mechanisms into theoretical systems, thus offering comprehensive explanations of all the possible ways in which music can induce emotions in listeners: Juslin's BRECVEMA theory (Juslin, 2013b; Juslin et al., 2010; Juslin & Västfjäll, 2008) and Scherer's Multifactorial Process Model (Scherer, 2004; Scherer & Coutinho, 2013; Scherer & Zentner, 2001).

2.1 Juslin and colleagues' BRECVEMA theory

The BRECVEMA theory assumes as its starting point that musical emotions cannot be accounted for by mechanisms of cognitive appraisal because, unlike everyday emotions, musical stimuli are not generally relevant for the individual's goals and survival. With this premise, Juslin and collaborators have identified eight psychological mechanisms, which according to them, do not involve cognitive appraisal, and that lead to the induction of a variety of affective states, from general arousal, to full-blown, discrete emotions. These mechanisms are not exclusively dedicated to processing musical information, but have developed through evolution to process auditory events and to guide future behaviour (Juslin, 2013b, p. 240).

Brain stem reflex. A primitive and automatic response to sudden acoustic events in the music (sudden, loud, dissonant or accelerating sounds) which would induce feelings of *surprise* and increased *arousal* in the listener.

Rhythmic entrainment. A mechanism activated when the music has marked rhythm, so that "some internal bodily rhythm of the listener" adjusts and locks-in to a common periodicity (Juslin *et al.* 2010, p. 621). This synchronization, in turn, would lead to increased *arousal*, and it could also potentially induce feelings of *communion*.

Evaluative conditioning. A mechanism activated because of the repeated association of a piece of music with other positive or negative stimuli. It would lead to the induction of the same *basic emotions* even in absence of the other stimuli.

Emotional contagion. A process of internal mimicry of basic emotions expressed by the music that would lead to the induction of the same *basic emotion* in the listener.

Visual imagery. A mechanism whereby the listener builds inner images of an emotional character through metaphorical mapping of the changes in the musical stream. This would usually induce feelings of *pleasure* and *deep relaxation*, but it could potentially induce *any emotion*.

Episodic memory. The process of conscious association of a particular piece of music with a specific emotional event in the listener's life which produces the reinstatement of the same emotion in the present situation. This mechanism could potentially induce *any emotion*, but it would frequently lead to the induction of feelings of *nostalgia*, *pride* and *longing*.

Music expectancy. A mechanism whereby emotions are induced when the schematic expectations aroused by the music are violated, delayed or confirmed. This mechanism would induce feelings of *interest*, *anxiety*, *surprise, hope*, *disappointment* and *chills*.

Aesthetic Judgment. A mechanism activated when a listener assumes a contemplative or evaluative attitude towards music. It would lead to experiences of *wonder*, *satisfaction*, *admiration* or merely *pleasure* (or of *boredom*, *irritation,* or *frustration* if the evaluation of the music is negative).

2.2 Scherer and colleagues' Multifactorial Process Model

Scherer's theory of induction of musical emotions is an extension of his theory of emotion causation, the Components Process Model (CPM) (Scherer, 2009b). Developed within the tradition of appraisal theories (e.g. Arnold, 1960; Frijda, 1986; Lazarus, 1991; Oatley & Johnson-Laird, 1987), the CPM theory proposes that emotions are elicited when an event is evaluated in terms of its relevance, its consequences for the person's goals, the person's ability to cope with those consequences, and the significance of the event for the person's self-concept and social norms. All of these appraisal checks happen in quick succession, producing changes in multiple physiological and behavioural subsystems which, when coordinated, produce the event-focused responses that we call emotional episodes.

Perhaps because of the emphasis that the CPM model places on cognitive appraisal, Scherer has proposed that musical emotions cannot be fully accounted for by this type of processing, and therefore, they constitute a different type of emotional experience. In his view, even though appraisals can still be present when we experience music, they play a small role in the production of musically-induced emotions, because musical events do not usually have any urgent consequences for the individual's survival or well-being. Thus, Scherer proposes that musical emotions (and emotions elicited by art objects in general) are better thought of as *aesthetic* and *epistemic emotions* (Scherer, 2004). These emotions are different from regular, *utilitarian* emotions in that rather than being driven by concerns about our adaptation and well-being, aesthetic and epistemic emotions are driven by the evaluation of the intrinsic qualities of the piece of art, and "the degree of discovery and insight one achieves through novel and complex simulation in different modalities" (Scherer & Coutinho, 2013, p. 125). Hence, besides the appraisal checks involved in the elicitation of any emotion (relevance, implications, coping potential, and normative significance), Scherer and Coutinho have proposed four additional routes to the induction of musical emotions: memory associations, contagion and empathy, entrainment, and facilitation of pre-existing emotions (2013).

Appraisal. This route consists of the appraisal checks proposed for utilitarian emotions adapted to the case of music listening. Thus, Scherer and colleagues consider that low-level detection mechanisms such as *brainstem reflexes* and *evaluative conditioning* correspond to checks of *novelty* and *intrinsic pleasantness*; whereas the mechanism of *musical expectancies* corresponds to the *discrepancy from expectation* check. They also adapt the *coping potential check* from the CPM to include evaluations of *agency* (e.g. who is responsible for what happens the music?) and *control* (e.g. to what extent can I control what happens in/with the music?). Finally, they adapt the *normative significance* check to include the assessment of the *aesthetic value* of music (equivalent to Juslin's *aesthetic judgments* mechanism).

Memory Associations. In this route, past emotional events are evoked or re-combined, producing re-instatements of previous emotions. Thus, this route encompasses Juslin's *episodic memory* and *visual imagery* mechanisms.

Entrainment. This route coincides with the *rhythmic entrainment* mechanism proposed by Juslin. However, unlike Juslin *et al.* (2010), Scherer and colleagues do not specify which specific emotions this mechanism can induce. They just speculate that this mechanisms either "produces" or "intensifies" subjective feelings (2013, p. 125).

Emotional contagion. This route corresponds to Juslin's mechanism of the same name. The main difference with Juslin's proposal, is that for Scherer and colleagues, not only the acoustic characteristics of music can induce contagion; for them, the observation (or imagining) of the motor expressions involved in making the musical sounds can also lead to motor mimicry, and to emotional contagion.

Empathy. This route is different from contagion, in that the listener does not merely mimic the emotions expressed by the music or the musicians, but assumes an understanding attitude towards the observed persons, so that empathic feelings are aroused. They propose that this mechanism would be particularly important in live performances and in social listening settings.

Facilitation. In this route, emotional responses to music are aroused because the listening experience weakens or eliminates the control over the expression of a pre-existing emotion, producing a disinhibition effect.

2.3 Points of coincidence: types of mechanisms

As was probably made evident in the previous section, despite their apparent differences, there are several points of coincide between the BRECVEMA and the Multifactorial approaches. I summarise these coincidences below, using the classification of mechanisms of emotion elicitation proposed by Moors (2009). This classification shows how both theories propose the same types of psychological processing: rule-based mechanisms, association mechanisms, and sensorimotor mechanisms:

Rule-based mechanisms involve on-line computation of appraisals, that is, evaluations of the significance of the musical stimulus for the individual's goals (Clore & Ortony, 2000; Moors, 2009). These goals can be implicit, and based on perceptual representations (such as the goal of predicting how a musical phrase will continue), or explicit, and based on propositional representations (such as the goal of listening to a piece of music in order to evoke cherished memories). Hence, appraisal mechanisms range from very quick, primitive, and automatic computations, to slow, sophisticated, and deliberative ones. This broad view of appraisal as a process of stimulus evaluation (Moors, 2013), implies that, contrary to the Juslin and colleagues' claims (Juslin & Västfjäll, 2008), their theory includes cognitive appraisal mechanisms.

Among the group of mechanisms based on quick, non-conscious appraisals we find the **musical expectancy** mechanism, included in both theories. Since in this mechanism the listener's implicit goal is to predict how the music will unfold (Huron, 2006), then this mechanism can be regarded as a form of appraisal where the brain evaluates the success of its predictions by comparing the discrepancy between the expected sound and the actual sound in the musical stimulus. The results of this evaluation (i.e. the detected level of discrepancy), triggers an affective evaluation of the music. The **intrinsic pleasantness** check proposed by Scherer also belongs to this category, because in this mechanism, some aspects of the music (e.g. consonant sounds or soft timbres vs. dissonant and rough timbres) are implicitly and automatically appraised as good or bad.

Both theories also include mechanisms that involve slow, conscious appraisals. **Evaluations about the aesthetic value** of the music are likely to depend on conscious considerations about the music's novelty, message, expressiveness, beauty, and its accordance to stylistic conventions. Furthermore, many of **Scherer's appraisal checks** relate to how well the music fits the current goals of the individual and so also fall into this category: the extent to which the music fulfils the goal of the listener (e.g. relaxing, producing enjoyment, acquiring knowledge, etc.), the extent to which it relates to the listeners' social identity, and the level of control or agency that the listener has over the music.

The **empathy** route proposed by Scherer and colleagues can also be assigned to this second slow and conscious category, because when listeners empathize with the musician's emotions, the argument is they simulate the motivations and appraisal processes that cause the musicians to feel the way they do (Scherer & Coutinho, 2013, p. 139)

Associative mechanisms lead to the induction of emotions through the reinstatement of previously computed and stored appraisal patterns (Moors, 2009). These mechanisms work by detecting similarities between the present situation and past situations with emotional significance for the individual.

In the case of music this implies that previous associations of music with past emotional experiences lead to the reinstatement of those emotions when the listener encounters the same (or similar) pieces of music. This can occur without any conscious awareness of this link between both stimuli, as in the case of **evaluative conditioning**, or with complete awareness of the associations, as in the case of the **episodic memories** mechanism (Juslin & Västfjäll, 2008).

The **visual imagery** mechanism proposed by Juslin *et al.* (2008, 2010, 2013) can also be included in this category, because the images and narratives that the listener evokes while listening to the music are not completely new, but dependent on the activation of past emotional concepts and events.

S*ensorimotor mechanisms.* These mechanisms lead to the induction of emotions because an aspect of the music generates a sensorimotor resonance in the listener's brain, and this activation in turn activates other components of the emotional response.

The **brain-stem reflexes** mechanism proposed by Juslin (and included by Scherer as part of the **novelty check**) works under this principle. This mechanism produces innate, fixed and automatic responses to sudden musical events as if they signalled threat, thus inducing a startle response.

The synchronization of the listener's body to the musical rhythm in the **entrainment** mechanism also belongs to this category, because rather than depending on an evaluation of the significance of the musical stimulus, or on associations with previous experiences, the rhythmic synchronization occurs thanks to a sensorimotor resonance of bodily rhythms with musical ones. This resonance in turn produces a cascading effect (i.e. a spreading of activation) to other components of the emotion system.

A similar cascading effect is present in these theories' proposal of the **emotional contagion** mechanism. In this case, the internal mimicry of either the melodic aspects of the music (Juslin *et al.*, 2010), or the motor expressions involved in the production of the music (Scherer & Coutinho 2013) produces the activation of the whole emotional response.

2.4 Points of discrepancy: predicted induced affective states

Besides the explicit emphasis that Scherer's theory has on appraisal mechanisms, the most important difference between these two theoretical approaches is the predictions they make about the type of affective states that the mechanisms induce. For Scherer and colleagues, in line with the principles of the CPM model, the role of the theory is not to identify how the mechanisms cause *specific* emotions. Instead, the role of the theory is to identify the changes that these mechanisms produce in other subsystems (physiological reactions, action tendencies, behaviours, attention shifts, etc.) which when combined, produce the emergence of an emotion (Moors, 2014). Therefore, for these authors, even though music is more likely to induce some aesthetic emotions, in theory, the activation of the different routes and mechanisms can produce the activation of patterns of components that can potentially correspond to an infinite number of emotions. The authors behind the BRECVEMA theory, by contrast, have attempted to map the correspondence between the some of the BRECVEMA mechanisms (rhythmic entrainment, evaluative conditioning, visual imagery, episodic memory, expectancy, and emotional contagion) and the induction of discrete emotions, regardless of the influence of contextual and personal factors (Juslin, 2013b).

2.5 Strengths and limitations of these theories

I consider that by proposing these mechanisms and routes, both Juslin and his collaborators and Scherer and colleagues have made significant contributions to our understanding of how musical emotions are aroused. These theoretical frameworks are specific enough to derive empirical hypotheses, and at the same time, interpret past results. Nevertheless, I submit that they also have important limitations, most of which are related to the psychological reductionist approach that their authors have adopted:

1. Although these theories acknowledge that musical emotions emerge from the interaction of factors in the music, the listening situation and the individual, they lack detail about how this interaction occurs, or how it leads to different emotional experiences with music. Ultimately, both of these theories assume a psychological reductionist approach, focused on the intra-individual mechanisms underlying the processing of the musical stimulus. This is more evident in the case of Juslin's BRECVEMA theory, which does not take into consideration the role of the listener's present goals in her emotional responses.

2. These theories neglect the cultural dimension that is inherent to any musical experience. People do not only hear music as a flow of acoustical stimuli, people also perceive *meanings* as if they were embedded "in the music", and these meanings certainly go beyond a limited set of basic emotions. That is, when a person listens to music, he or she experiences it as a symbolic object loaded with cultural connotations which are contingent on the context of listening, and his or her abilities and goals (Clarke, 2005; Dibben, 2001). And in turn, the interaction between these culturally-constructed meanings, the structure of the music, and the idiosyncrasy of the individual produces particular and contextualized emotional experiences (cf. Dibben, 2006).

3. These theories do not explicitly address the intensity problem (Moors, 2009). They do not contain any explanations or predictions about how and why affective reactions to music vary in intensity. What makes a person react with an intense

emotional response to a piece of music on one occasion, and with a mild emotion (or even not react emotionally) on another occasion, or to a similar musical piece?

4. In making predictions about how different mechanisms lead to the elicitation of particular discrete emotions, the BRECVEMA theory addresses the differentiation problem (Moors, 2009). However, it does not address the more general question about which stimuli and mechanisms determine the induction of positive emotions, and which determine the induction of negative ones.

   Scherer's Multifactorial Process Model does not probe the question of differentiation of discrete emotions, because, as mentioned above, this approach proposes that the different routes can potentially result in the induction of an infinite number of emotions. However, unlike the BRECVEMA theory, Scherer's theory does include some predictions about how musical experiences lead to positive or negative affective reactions. Thus, if the results of the cognitive appraisals of goal conduciveness, coping potential and compatibility with social norms are negative then the listener will probably experience a negative emotional reaction. Moreover, this theory also predicts that some basic psychoacoustic parameters such as dissonance can intrinsically (and perhaps universally) be appraised as negative, and induce feelings of unpleasantness.

5. Although both the BRECVEMA theory and the Multifactorial Process Model aim to explain the emotions most frequently aroused by music, this epistemological decision has left unanswered the question of variability. In other words, this narrow focus has excluded numerous and important experiences that are certainly affective, but cannot be completely captured by the rather restricting concept of "emotion". Among these experiences are: moods, preferences, and quasi-physical sensations that are almost ineffable. And of course, by excluding these kinds of experiences, these theories have also left unanswered the question about the conditions under which these affective states relate to, or become discrete, full-blown emotions.

6. Unlike the Multifactorial Process Model, which is embedded within the CPM model of emotion causation, Juslin's BRECVEMA theory does not represent a "unified theoretical framework" (Scherer & Coutinho, 2013, p. 132). The mechanisms included in the BRECVEMA theory correspond to different levels of psychological functioning (e.g. some are thought to be automatic, unconscious and innate,

whereas other are thought to be slow, conscious and learned). However, Juslin and colleagues have yet to construct a systematic account of how these different levels and mechanisms interact with each other. They do not specify, for example, what would be the listener's emotional reaction if two or more mechanisms become activated simultaneously, producing different, or even incompatible emotional reactions. For example, according to their theory, a sad piece of music could at the same time, generate sadness via emotional contagion, evoke feelings of joy via episodic memories, and feelings of anxiety through the musical expectancy mechanism. Would any of these emotional reactions take prominence in the listener's experience? Or would the listener experience a blend of mixed-emotions? Which processes decide between these two alternatives? The BRECVEMA theory does not offer any predictions about this type of questions. The only case where the theory addresses the case of *mixed emotions* is that of musically-induced sadness, which Juslin speculates can be generated when a contagion response of sadness is co-activated with an aesthetic evaluation of the music as beautiful (Juslin, 2013b, pp. 258–259).

7. Finally, given the definition of emotions adopted at the start of this chapter, according to which emotional episodes are always directed toward an object, I find Juslin and colleagues' predictions about how the activation of some of the BRECVEMA mechanisms can *on their own* lead to discrete emotions unlikely (Juslin & Västfjäll 2008, p. 571, table 4). This prediction seems difficult to reconcile with the premise, (shared by both Juslin's and Scherer's theories), that musical emotions are the product of the interaction of factors in the music, the listener and the context. Moreover, the authors of the BRECVEMA theory have backed this assumption on the findings of studies that did not control for the simultaneous activation of other mechanisms, nor for the influence of personal and contextual factors (e.g. Janata, Tomic, & Rakowski, 2007; McKinney, Antoni, Kumar, Tims, & McCabe, 1997; Sloboda, 1991). Hence, this lack of control makes it hard to conclude the extent to which a single factor was responsible for the induction of the observed discrete emotion.

I dedicate the next section of this chapter to controvert the assumption that the activation of single mechanisms can lead, on its own, to the induction of discrete emotions.

2.6 Can full-blown emotions be induced by the activation of single mechanisms?

Two essential elements in the consensual definition of emotion proposed in chapter one are that emotional episodes are always felt as caused by an object, and that they are always elicited by personally-relevant events. Several of the mechanisms proposed in the BRECVEMA theory (some of which are also included in Scherer's proposal) can clearly lead to the induction of emotions thus defined, because they imply establishing associations between the musical stimulus and emotionally meaningful events in the listener's past. As mentioned in section 2.3 above, the episodic memories, evaluative conditioning, and visual imagery mechanisms share the same underlying associative processing: they activate emotional memories, and this activation in turn re-instates the same emotions that the person experienced in the past. Therefore, it can be assumed that the affective responses activated by these mechanisms constitute emotions proper, because these retrieved memories provide them with an element of personal relevance, and a sense of "aboutness" (i.e. the memories provide them with objects towards which the affective response is directed).

Controversially, according to the BRECVEMA theory, even mechanisms that do not involve associative processing can also induce discrete, full-blown emotional responses. Thus, according to Juslin and colleagues, the musical expectancy mechanism leads to the induction of anxiety and disappointment, the entrainment mechanism leads to feelings of communion, and the emotional contagion mechanism leads to the elicitation of basic emotions (Juslin *et al.* 2008, 2010, 2013). I critically analyse these assumptions in the expectancy and the rhythmic entrainment mechanisms in the final sections of this chapter. Since the emotional contagion mechanism requires a more exhaustive argumentation, I devote the next chapter in its entirety to it.

2.6.1 The Musical Expectancy Mechanism

My suggestion is that the expectancy mechanism by itself can only lead to the induction of quick and diffuse affective responses, the majority of which correspond to small changes in arousal that are only detectable by using physiological measurement techniques. Several theoretical and empirical arguments support this claim. The theoretical arguments can be found in Huron's ITPRA theory (2006), according to which, whenever a piece of music violates a listener's expectation, the initial "reaction response" is limited to detecting the failure of a prediction. On most occasions this response is non-conscious, and only observable in subtle changes in skin conductivity, and small variations of electrical activity of the brain (Koelsch, Kilches, Steinbeis, & Schelinski, 2008; Steinbeis, Koelsch, & Sloboda, 2006). On other occasions, the violation of the expectation can be so obvious that the listener consciously experiences surprise. In any case, since these initial responses are either limited to physiological changes, or un-valenced (a surprise, while it lasts, is neither positive nor negative), they cannot be considered emotions. Indeed, according to Huron's theory, the reaction response is followed by the activation of "slow and more complex" appraisal mechanisms, which attribute meaning to the initial startle-like response (Huron, 2006, p. 14). In the ITPRA theory, this meaning attribution leads to the induction of conscious affective responses such as awe, laughter, comfort, jealousy, contempt, loneliness, compassion, pride and humour[3] (p. 18).

Empirical evidence for the claim that the musical expectancy mechanism provokes mainly quick changes in arousal can be found in several investigations: First, Sloboda (Sloboda, 1991) found that expert musicians' reports of musically-induced *chills* tended to occur in moments where the music violated harmonic expectations. (According to the consensual definition proposed in section 1.2 of Chapter 1, chills are physiological responses whose occurrence cannot by itself be considered full-blown emotions). Second, an fMRI study conducted by Koelsch and colleagues (Koelsch, Fritz, Schulze, Alsop, & Schlaug, 2005) found that violation of harmonic expectations correlated with the activation of the orbital frontolateral cortex, a brain area associated with evaluating the emotional valence of stimuli. However, in a subsequent experiment Steinbeis, Koelsch and Sloboda (Steinbeis *et al.*, 2006) found that violations of musical expectancies correlated with measures related to arousal, not with valence. Their results indicated that the more the musical stimuli violated the listeners' harmonic expectations, the higher their skin conductance response, their ratings of perceived musical tension, and of induced emotional intensity. In contrast, their heart rate activity (a physiological measure associated with valence), did not correlate with expectation violations. These findings led these researchers to conclude that "harmonic expectancy violations lead only to an increase in arousal, rather than bearing on the valence of the emotional experience" (p. 1390). A third experiment confirmed this conclusion: Koelsch

---

[3] It is important to note that for Huron, these appraisal mechanisms are not only slow, but conscious.

and colleagues (2008) found that unexpected chords were associated with increased skin conductance responses, and with neuroelectric responses in the brain, but not with changes in heart rate.

The conclusions of these studies, which focused on violations of harmonic expectations, were largely confirmed in a recent experiment that focused on violations of melodic expectations. Egermann and colleagues (Egermann, Pearce, Wiggins, & McAdams, 2013) asked participants to listen to a live performance of solo flute pieces, to rate how unexpected they found the events in the music, and to rate their affective experience on the two-dimensional space (i.e. arousal and valence). Additionally, they measured the participants' heart rate, respiration rate, skin conductance response, and facial EMG (corrugator and zygomaticus activity). The researchers found that compared to melodic events subjectively experienced as very expected, unexpected events were associated with higher ratings of experienced arousal, increased skin conductance response, and decrease heart rate; but not with changes in experienced valence, respiratory rate, nor facial EMG. When the researchers used an objective measure of melodic unexpectedness, they observed a small and negative association of highly unexpected events with ratings of valence (the regression mode yielded a Beta value of .001 for this variable, Table 5 p. 545). Moreover, neither the objective nor the subjective measures of unexpectedness (objective and subjective) correlated significantly with the participants' facial behaviour, as measured with EMG.

In contrast with these studies, which concluded that violations of musical expectations are mainly associated with changes in arousal, a couple of studies carried out by Juslin and colleagues (2013, 2015) reported that the musical expectancy mechanism led to the induction of full-blown emotions. However, as I go on to argue below, these results can still be interpreted as supporting the above-mentioned claim. In the first of these studies, Juslin, Harmat and Eerola (Juslin, Harmat, & Eerola, 2013) synthesised four versions of a musical piece, with the objective of selectively activating four mechanisms from the BRECVEMA framework: brain stem responses, emotional contagion, episodic memory, and musical expectancy. They found that contrary to their prediction, the version intended to activate the expectancy mechanism did not arouse anxiety, but irritation. In the second study, Juslin, Barradas and Eerola (Juslin, Barradas, & Eerola, 2015) used existing pieces of music with the objective of activating the same four mechanisms. Their results showed that as predicted, the pieces aimed at activating the expectancy mechanism led to the highest ratings of anxiety, but also, surprisingly, of sadness. They also found that the pieces associated with the induction of negative emotions (such as the pieces designed to activate the expectancy mechanism), led to increased activation of the corrugator muscle in the participants' faces (i.e. frowning).

Why did Juslin and colleagues hypothesise that the expectancy mechanism would induce anxiety, and not a more "neutral" response such as surprise, bewilderment or confusion? An examination of the stimuli they used can help explain their prediction. In the first study, the harmonic structure of the musical stimulus was manipulated to make it less conventional, so it ended up resembling "the harmonic choices characteristic of Stravinsky's serial period" (Juslin *et al.*, 2013). In the second study (Juslin *et al.*, 2015), the musical pieces intended to activate the expectancy mechanism were avant-garde pieces of classical music which depart largely from the harmonic and melodic conventions of the common practice period (i.e. pieces by Stravinsky and Berg from the first three decades of the 20thcentury). The implication of these methodological decisions is that in both studies, the musical stimuli made it really hard to establish any stable expectations at all. Moreover, the pieces used in the second study were characterised by the presence of dissonant intervals, frequent *subito forte* sounds, and strange melodies, which make them sound like horror movie soundtracks. It is telling that in both studies the pieces aimed at activating the expectancy mechanism were the least liked overall (except for a repetitive piece used as "neutral" stimulus in the second study). Moreover, in the second study, three out of the four stimuli aimed at activating the expectancy mechanism elicited the same levels of anxiety as the stimuli aimed at activating the brain stem mechanism, which was itself supposed to elicit surprise.

I believe that given these characteristics of the stimuli, rather than testing the effects of violation of expectations per se, these authors tested the effects of being exposed to unpleasant music. Taken together, the results of these two studies can be interpreted as suggesting that the unpredictability of the music, its constant dissonance, and its subito forte sounds, led to increased feelings of negative valence, and to associations of the music with horror movie scenes. Thus, an alternative explanation of the finding that participants chose discrete emotion adjectives to describe their feelings is that the questionnaires used by the researchers contained only discrete emotions as response options, and not adjectives describing more general and abstract affective states. Perhaps, if presented with the choice between reported they felt "tense", "uncomfortable" or just "bad", instead of "nervous", "angry", or "sad", the participants would have chosen the first type of general affective adjectives, instead of the discrete ones.

Additionally, the observed variability in the emotions reported by the participants can be explained by the activation of associative mechanisms. Thus, the more the participants associated the induced unpleasantness with past memories (of movies, for example), the more likely they were to report they felt anxious or sad. And the less they managed to make those associations, the more they simply felt a state of frustration, and chose the “irritation” option in the questionnaire, accordingly.

2.6.2 The Rhythmic Entrainment Mechanism

A similar argument to the one presented in the previous section can be put forward for the case of the rhythmic entrainment mechanism: without the co-activation of associative mechanisms and of relevant contextual information, the activation of this mechanism can only lead, on its own, to the induction of basic affective responses.

According to the BRECVEMA theory, in the rhythmic entrainment mechanism, the synchronization of “some internal bodily rhythm of the listener” to a “powerful, external rhythm in the music” does not only lead to increased arousal, but also to the induction of more sophisticated emotional states such as feelings of “communion”, of being “connected” and of “emotional bonding” (Juslin, 2013b, p. 241). My suggestion, by contrast, is that it is unlikely that a mechanism that involves only the activation of non-conscious sensorimotor processes such as physiological synchrony has the potential to lead to affective reactions beyond fluctuations of arousal and valence. Moreover, I propose that only the presence of a relevant listening context in which there are other people playing, dancing, or simply moving in synchrony with the music can lead to the induction of feelings of communion and of emotional bonding.

The evidence for the effects of rhythmic entrainment on affective responses is so far scarce. (Chapter 6 tests the hypothesis that rhythmic entrainment induces changes in arousal and valence). To my knowledge, three recently published experiments have provided partial, and somewhat contradictory findings in relation to the hypothesis that entrainment leads to changes in arousal, and/or valence, as summarised below.

The first of these studies aimed at showing how the construct of “groove” is manifest in musical behaviour and thinking (Janata, Tomic, & Haberman, 2012). The researchers found that, contrary to their prediction that moving in time with groovy music would be pleasant, asking participants to tap along with the music hampered their enjoyment, and that the participants' mood became more negative during the experiment.

In second place, two research teams carried out experiments investigating rhythmic entrainment, but unlike Janata and colleagues, they did not ask the participants to produce any observable motor responses to the music, and they did not measure their level of physiological entrainment either, a limitation that makes their conclusions problematic, since they did not provide any evidence that an aspect of the participants' bodily rhythms synchronized to the music. Thus, using a web-based questionnaire, Witek *et al.* (Witek *et al.*, 2014) asked participants to listen to drum-breaks with different levels of syncopation, and found that participants reported higher feelings of induced pleasure when listening to stimuli with an intermediate syncopation level.

Labbé and Grandjean (Labbé & Grandjean, 2014) asked participants to listen to pieces for solo violin played in a deadpan, regular, or exaggerated expressive way, and to rate their feelings of entrainment, their level of emotionally involvement, and their induced emotions in the GEMS scale (Zentner et al., 2008). The results indicated that, as expected, the deadpan pieces were associated with the lowest ratings of aroused emotionality. A factorial analysis of the participants' feelings of entrainment categorised their ratings into two dimensions: feelings of bodily agitation (which the authors call "visceral entrainment"), and urges to move in time with the music (which they call "motor entrainment"). Although this finding is compatible with Juslin and colleagues' hypothesis about how rhythmic entrainment leads to increased arousal, Labbé and Grandjean propose that the two dimensions are associated with different emotions from the GEMS questionnaire. An alternative explanation, not explored by these researchers, is that the observed discrete emotions are on the one hand, an artefact of asking participants to rate their experience using emotional adjectives, and on the other, that the discrete emotional states were induced by other mechanisms which were not controlled for in the experiment. For example, how could it be possible for a participant to report having feelings of "spirituality" or "transcendence" without having associated them with some sort of religious or metaphysical meaning?

If the evidence so far is at least partially compatible with the BRECVEMA hypothesis that rhythmic entrainment leads to increased arousal, the evidence for the hypothesis that it leads to feelings of emotional bonding supports it more clearly. However, at the same time, the evidence is also compatible with my proposal that these kind of feelings can only be induced in relevant listening contexts, where the listener is in the presence of other people synchronizing their movements to the music; as summarised below.

Demos and colleagues (2012) instructed pairs of participants to rock their chairs side by side, and found that participants who coupled their movement more strongly with the music reported feeling more connected to their partners. Kirschner and Tomasello (2010) compared the prosocial behaviour of two groups of four years-old children who engaged in tasks involving synchronization. They found that compared to pairs of children who engaged in a synchronized but non-musical task, children who did a similar musical task exhibited more subsequent cooperative and helpful behaviour. Finally, Tarr and colleagues (Tarr, Launay, Cohen, & Dunbar, 2015), asked four groups of adolescents to dance with different levels of synchronization and physical exertion to music, and measured their mood, change in pain threshold, and closeness towards other adolescents. Their results indicate that higher levels of synchronization and exertion were associated with increased pain threshold; that none of these variables had an effect on the participants' mood, and that increased synchronization and exertion were associated with self-reported closeness towards members of the adolescents' in-group.

In summary, the results of research so far do not allow to draw solid conclusions about the effects of rhythmic entrainment on affective states when the participants engage in individual listening tasks. While some studies have found positive effects on ratings of pleasure, other have found null results, or have suggested that the effects are more marked at the level of arousal (as predicted by Juslin and colleagues), or at the level of discrete emotions. The evidence for the BRECVEMA prediction that rhythmic entrainment leads to feelings of emotional bonding is, in contrast, more positive and consistent, but it is also in accord with my suggestion that this type of feelings only emerge in the presence of at least another individual who simultaneously synchronizes with the music. (Admittedly, since no study has compared the effects of individual entrainment versus collective entrainment, my hypothesis remains speculative).

2.7 Conclusion

In this chapter I have presented a critical review of the two most comprehensive contemporary theories on the induction of emotion by music: the BRECVEMA theory and the Multifactorial Process Model. I have shown how these two theories postulate the same type of underlying mechanisms, and how their main differences lie in the greater role that the Multifactorial Process Model attributes to appraisal mechanisms, and in the predictions of the BRECVEMA theory about the induction of discrete emotions by single mechanisms. I have also shown how the psychological reductionist approach that these theories have assumed has prevented them from providing satisfying answers to some of the central questions that an emotion elicitation theory should address, and has made them neglect the role that personal, contextual and cultural variability have in musical emotions phenomena. Finally, drawing from these criticisms, I have argued against the above-mentioned claim of the BRECVEMA theory that the activation of the expectancy and entrainment mechanisms can lead to the induction of full-blown emotions. I continue this critique in the next chapter, where I address this problematic assumption in the case of the emotional contagion mechanism.

3. The problematic case of the emotional contagion mechanism

On many music listening situations, when we perceive that a piece of music expresses a particular emotion, we have the feeling that the same emotion is aroused in ourselves. This phenomenon has been dubbed “emotional contagion” (Davies, 2010; Schubert, 2013), and is considered by the BRECVEMA theory as one mechanism of emotion elicitation by music. According to this theory, musical emotional contagion occurs thanks to the existence of a shared acoustic code to the expression of emotions in music and speech prosody (Juslin & Laukka, 2003). Drawing from theories such as Ekman’s (1992) and Panksepp’s (2000), Juslin and colleagues theorise that this code is organised into discrete categories, called “basic emotions”. In this perspective, basic emotions are considered innate and universal affect programs, which evolved through phylogenesis to serve important survival functions. This view carries several empirical predictions: facial and vocal expressions of emotions (and therefore musical expressions of emotions too) are more readily perceived than other non-basic emotions, are expressed and perceived equally across cultures, appear early in development (Izard & Malatesta, 1987), have distinct brain substrates (Panksepp, 2000), are associated with distinct patterns of physiological activation (Ekman, Levenson, & Friesen, 1983), and form the basis for other, non-basic emotions (Izard, 1992; Plutchik, 1980). Additionally, vocal and facial emotional expressions can also be identified in other species (Geen, 1992).

For the BRECVEMA theory, the existence of this shared code in vocal and musical expression of basic emotions explains the frequently observed coherence between perceiving an emotion expressed by the music, and the induction of the same emotion in the listener (Schubert, 2013). According to this theory, this process of *emotional* *contagion* occurs thanks to the activation of a brain module that responds automatically to voice-like aspects of music as if they were coming from a "super-expressive" human voice, triggering process of internal mimicry:

> "*Emotional contagion refers to a process whereby an emotion is induced by a piece of music because the listener perceives the emotional expression of the music, and then "mimics" this expression internally, which by means of either peripheral feedback from muscles, or a more direct activation of the relevant emotional representations in the brain, leads to an induction of the same emotion.*" (Juslin & Västfjäll, 2008, p. 565)

The BRECVEMA theory of emotional contagion is in turn based on its authors' two models of musical meaning: their theory of musical expressivity, and their model of musical communication.

The first model, Juslin's theory of musical expressivity, proposes that perception of musical emotions is based on three "layers" of coding of musical expression (Juslin, 2013). The first layer is constituted by *iconic* resemblances between musical sounds and the expression of basic emotions in vocalizations. The second layer, called *intrinsic coding*, consists of patterns of harmonic change in the music that can denote fluctuations of tension and relaxation. The third layer, called *associative coding*, consists of arbitrary associations of musical sounds with objects and events, which provide cues to contents expressed by the music for a listener familiarised with those associations. Clearly, the emotional contagion mechanism, as described by the BRECVEMA theory, depends on the existence of the first, iconic coding layer.

The second model of musical meaning proposed by the BRECVEMA theory consists of a functionalist model of musical communication (Juslin, 2003). It proposes that senders (i.e. music performers or people talking emotionally) use a number of probabilistic and partly redundant acoustic cues to encode their emotional message. These cues leave traces in the acoustic object which can be subsequently detected by receivers (i.e. music listeners or conversation partners), who use them to decode and identify the intended emotion. Each cue in isolation is not a perfect indicator of the expressed emotion, and therefore the more cues are present in the acoustic object, and the more cues are used by decoders, the more likely it is that accurate communication takes place. Additionally, because some of the cues are partly redundant (i.e. they are associated with the same expressive intention), there are several cue combinations that can lead to successful communication.

As can be seen from the preceding paragraphs, the emotional contagion mechanism is the aspect of the BRECVEMA theory where its authors most clearly adhere to a psychological reductionist view according to which, the power of music to communicate and to induce emotional experiences depends only on the process of encoding and decoding of acoustic information present in the musical object. In other words, despite their claim that their theory allows for the contribution of factors in the person, and in the listening context (Juslin, 2013, p. 7), in this point the BRECVEMA theory assumes that emotional meanings are somehow, *embedded* in the music, and that these inherent meanings can lead, without the mediation of any personal or contextual factors, to the induction of discrete emotions.

I refute this assumption in this chapter. In the first section, I criticise the concept of basic emotions. Subsequently, I review the problematic evidence that supports the existence of shared acoustic code to the expression of basic emotions in vocalizations and music. Finally, I criticise the application of the concept of Basic Emotions for musical expressions of emotion. In the experiments reported in chapters 7 and 8 of this thesis, I examine the evidence for the second half of the emotional contagion hypothesis proposed by the BRECVEMA theory: the notion that this process of contagion occurs thanks to the activation of mechanisms of internal mimicry.

3.1 The problems with the concept of Basic Emotions

The first group of arguments comprising my critique are concerned with the concept of Basic Emotions itself. The authors who defend the concept of Basic Emotions conceive them as biologically primitive (i.e. supported by hardwired, discrete biological subsystems) and/or as psychologically primitive (i.e. as having elementary eliciting conditions, and forming the basis for other emotions) (Ortony & Turner, 1990; Scarantino & Griffiths, 2011). The biological primitiveness assumption is contradicted by findings that the same biological subsystems serve emotional and non-emotional psychological processes, and that even structures traditionally associated with discrete emotions (e.g. amygdala and fear), are involved in several emotions such as anger, happiness, and sadness (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012; Raz *et al.*, 2016). The psychological primitiveness assumption, in turn, is challenged by the consideration that several emotions traditionally considered as “basic”, share more elementary components. For instance, Anger, Sadness, and Disgust share a component of displeasure; and both Anger and Fear involve an evaluation of a situation as obstructing the realisation of the individual’s goals (Ortony & Turner, 1990; Scherer, 2009a).

An additional problem with the Basic Emotion construct is that those who defend it do not agree on which emotions should be considered “basic”. Every author who proposes the existence of basic emotions has submitted a different list, ranging from two categories (Weiner & Graham, 1984) to ten (Izard, 1977). For instance, whereas Panksepp (2007) identifies seven “basic emotional responses” (Seeking, Rage, Fear, Lust, Care, Panic, and Play), Ekman and Cordaro (2011) propose slightly different seven categories (Anger, Fear, Surprise, Sadness, Disgust, Contempt and Happiness). Moreover, “love” or “tenderness”, an emotion included by Juslin in the list of basic emotions that vocalizations and music are able to express (2013), only appears in 4 out of the 14 theories reviewed by Ortony & Turner (1990), none of which is more recent than 1960. This figure increases to five theories if we consider Panksepp’s (2007) “care” category as equivalent.

In a paper dedicated to presenting his theory of how music expresses basic emotions, Juslin (2013) argues that these disagreements do not constitute a problem, because the concept of basic emotions has heuristic value for the researchers who have adopted it, and because there is greater agreement about which emotions should be considered basic, than about how emotions should be defined in general (2013, p. 6). In my view, these arguments do not solve the problem. First, the fact that affective science has a problem agreeing on a definition of emotion is very serious, but probably not as unsurmountable as Juslin makes it appear to be, as demonstrated by the consensual definition proposed in the first Chapter of this thesis[4]. Second, the existence of that lack of consensus does not make the lack of agreement among Basic Emotion theorists less serious. Third, even though it is true that several research programs have used the basic emotions concept in a heuristic manner, the fact that their lists and definitions do not match completely has made it difficult to accumulate the evidence into a single coherent conceptual framework. For instance, since anxiety, stress, distress, fear, and terror are similar but not identical states and concepts, the conclusions of research into

---

[4] This consensual definition is in fact, very similar to the one proposed by Juslin and Sloboda in the introductory chapter to their Handbook of Music and Emotion (Juslin & Sloboda, 2010b, p. 10).

these affective states are not necessarily consistent (c.f. Kreibig, 2010, p. 410). And finally, this narrow focus on a limited set of emotions has made affective science lose sight of the great variety of emotional experiences that people have during their life-span and across different cultures, and of the relationship between these discrete, full-blown emotions and other affective states such as moods, preferences, and attitudes.

3.2 The problematic evidence for the existence of Basic Emotions

The second group of criticisms of the Basic Emotion approach is the lack of solid empirical evidence for their claim that basic emotions are biologically hardwired affect programs. After decades of research, there is still no strong evidence for the existence of distinctive patterns associated with discrete emotions at the neural, physiological, and behavioural levels.

Regarding the evidence for dedicated brain systems associated with discrete emotions, the main conclusion drawn from recent reviews is that instead of discrete subsystems associated with each basic emotion, there are specific brain areas associated with specific behaviours (e.g. freezing, attacking, smiling), which are sometimes present when emotions are elicited (Barrett, 2006a; Lindquist *et al.*, 2012). Similarly, reviews of the evidence for distinct patterns of peripheral physiological activation have failed to find robust and consistent patterns distinguishing discrete emotion categories (Cacioppo, Bertson, Larsen, Poehlmann, & Ito, 2000; Kragel & LaBar, 2013; Kreibig, 2010; Stephens, Christie, & Friedman, 2010)[5]. A more parsimonious interpretation of these results is that physiological activation is mapped onto more general dimensions corresponding to arousal and valence, or to preparation to approach/avoid the eliciting stimulus (Barrett, 2006a; Mauss & Robinson, 2009).

Regarding facial and vocal expressions of emotions, there is little and conflicting evidence for the claim that the patterns predicted by Basic Emotion theories such as Ekman's (Ekman & Friesen, 1984) are present in spontaneous emotional expressions (Camras *et al.*, 2002; Carroll & Russell, 1997; Gosselin, Kirouac, & Doré, 1995; Scherer &

---

[5] Two of these studies claim to have found distinctive patterns of autonomic activation associated with basic emotions. However although these studies used similar pattern classification methods and stimuli, they did not replicate each other in the patterns they report (Kragel & LaBar, 2013; Stephens *et al.*, 2010).

Ellgring, 2007). Vocal expression of emotions have been much less researched than facial expressions, and most of this research has been carried out using portrayed expressions as stimuli, so there is little data about the extent to which these posed expressions correspond to natural ones (Scherer, 2003).

The strongest piece of empirical support for Basic Emotion theories is the finding that participants attribute the same emotional states to photographs of portrayed facial expressions above chance level (70% on average, according to Scherer, Clark-Polner, and Mortillaro, 2011). Nevertheless, this agreement level lessens when participants are asked to rate natural or milder expressions, when participants observe dynamic rather than static expressions, when researchers use open-ended questionnaires rather than lists of a few emotional adjectives, when participants rate expressions made by people from a culture different to their own; and importantly, when the stimuli consist of *vocal* expressions (Elfenbein & Ambady, 2003; Russell, Bachorowski, & Fernández-Dols, 2003).

Key to the BRECVEMA theory of emotional contagion is the claim that there are acoustic patterns in vocalizations associated with discrete, basic emotions (Juslin & Laukka, 2003). However, this prediction is not clearly supported by empirical evidence so far. The most consistent finding in studies analysing the acoustic qualities of emotional prosody is that these psychoacoustic cues correlate most clearly with differences in arousal. More specific acoustic patterns distinguishing variations in valence, or distinguishing discrete emotional states have been more difficult to identify (Bachorowski, 1999; Juslin & Scherer, 2005; Russell *et al.*, 2003; Scherer *et al.*, 2011). Scherer, Juslin and colleagues (Juslin & Scherer, 2005; Scherer, 2003; Scherer et al., 2011) have argued that this situation is due to the fact that most research has studied a limited number of acoustic cues, and has neglected arousal differences present within "emotion families" (e.g. the differences between repressed anger and explosive anger). In their joint paper, Juslin and Scherer go as far as proposing that affective states of a relatively weak intensity are probably only differentiated in terms of the arousal and valence dimensions (Juslin & Scherer, 2005, p. 91); an observation that suggests that clear-cut psychoacoustic patterns could only be identified when emotional expressions are intense, that is, when the vocalizations used as stimuli in research are as exaggerated as the expressions traditionally used in research on facial expressions of emotion.

In spite of this panorama of inconclusive evidence, Juslin, Scherer, and their collaborators have continued to search for acoustic patterns associated with discrete emotions, and they claim to have found them. The evidence they have put forward for this assertion, however, is not without problems, as I show in the following paragraphs.

The first source of evidence for Scherer's claim is an experiment from 1996, in which 12 actors portrayed 14 emotions using meaningless sentences (Banse & Scherer, 1996). These vocalizations were judged by other 12 drama students, and 29 of their acoustic qualities were analysed. They found, as many other studies before, that the clearest acoustic differentiation between the stimuli was the differences in mean fundamental frequency (F_0), which correlated with different degrees of arousal. Additionally, they found several statistically significant, but modest differences for discrete emotions. This conclusion, however, should be qualified by two observations: a) the tests that yielded these different patterns were not carried out on all the 1344 vocal samples obtained from the actors, but on a subset of 224 samples that were judged as best acted; b) just as in most research on facial expressions of emotion, this study used portrayed emotional expressions, which do not necessarily correspond to naturally-produced ones, and therefore, these conclusions lack ecological validity.

The second source of evidence for Scherer's claim about a link between acoustic parameters and discrete emotions is a summary of findings that he has presented in several papers (Scherer, 2003; Scherer et al., 2011; Scherer, Johnstone, & Klasmeyer, 2003). Intriguingly, in none of these papers do Scherer and colleagues clarify how many investigations are included in the summary, nor the basis for choosing the "selected empirical findings" that they report (Scherer *et al.*, 2011, p. 414). In any case, an analysis of this summary leads again to the conclusion that most acoustic parameters are associated with variations of arousal. The results suggesting the existence of acoustic parameters associated with specific emotions are few, and not robust. For instance, the only parameters that distinguish Anger from Fear are the ratio of Harmonic/noise (high in Anger, Low in Fear), and the precision of location of the formants, which are higher in Anger, and which can be lower or equal in Fear (Scherer *et al.*, 2011, p. 414, Table 3).[6]

Juslin's arguments about the existence of specific acoustic patterns for discrete emotions are based on a review that he carried out with Laukka (2003), in which they analysed the results of 104 studies on vocal expression of emotion, and 41 studies on

---

[6] An even more recent study by Scherer and colleagues which compared vocalizations in French and German confirmed the finding that most psychoacoustic cues are strongly associated with variations in arousal, and that there are small or non-existent associations with variations in valence (Bänziger, Patel, & Scherer, 2014).

musical expression[7]. For these authors, the results of this meta-analysis show that there are enough acoustic differences in emotional prosody to distinguish five basic emotions: Anger, Fear, Happiness, Sadness, and Love-Tenderness. However, a detailed examination of this evidence shows that there are at least three reasons to be sceptical about this conclusion.

First, the majority of the studies included in the review (87%) used portrayals by actors. This type of studies tells us how actors *think* emotions should be portrayed, rather than how they *actually* happen. Hence, their usefulness consists in informing us about people's prototype or ideal expressions for hypothetical, full-blown emotional states.

Second, most of the findings about associations between acoustic cues and discrete emotions indicate that most of the cues are the same for emotions that have the same level of activation (Juslin & Laukka, 2003, pp. 792–795). For instance, Sadness and Tenderness, the two emotions with low activation level, correlate with slow speech rate, low intensity, low frequency energy, low mean fundamental frequency (F_0), and downwards contours. Whereas Anger, Fear, and Happiness, the emotions with high activation level, correlate with fast speech rate, high intensity, high voice intensity variability, high frequency energy, high mean fundamental frequency, low fundamental frequency variability, and upwards contours.

Third, only two of the nine acoustic parameters summarized in the review distinguish emotions beyond their level of activation. But even there, the results do not point to robust and consistent differences. Juslin and Laukka conclude that F_0 variability distinguishes Anger (high variability) from Fear (low variability). Nevertheless, there are almost as many studies that found that Fear is associated with high or medium F_0 variability (n = 15) than the number of studies that found that it is associated with low variability (n = 17). In fact, if we exclude from this list a study that found that Fear is associated with both medium and low variability, and a study that found that this emotion is associated with both high and low variability, then the number of studies reporting low and high or medium variability is the same (n= 15), and the distinction between Anger and Fear in terms of F_0 variability becomes less clear. The second acoustic cue that distinguishes emotional expressions beyond arousal in the review is the level of microstructural regularity of the voices. However, this finding is based only

---

[7] I analyse their evidence for patterns associated with musical expression of emotion in the next section of this chapter.

on 5 studies (out of 104), and they can be interpreted as distinguishing between positive and negative valenced emotions: Happiness and Tenderness are associated with microstructural regularity, whereas Anger, Fear, and Sadness are associated with microstructural irregularity.

In summary, in this section I have shown how, despite the predictions of Basic Emotion theories, there is little and inconsistent evidence for the existence of distinctive patterns associated with discrete emotions at the physiological, neural and expressive behaviour levels (i.e. facial expressions and speech prosody).

Before analysing the evidence that music expresses basic emotions, it is important to clarify the scope of the criticism I have presented so far to the notion that emotions have associated facial and vocal expressions. My claim is not that emotional episodes have absolutely no effects on facial and vocal behaviour. It is very unlikely that emotions have no consequences on our facial behaviour and on our speech prosody. Moreover, these effects should be more obvious in very intense emotional episodes, when the eliciting situation is so personally relevant and urgent that we feel overtaken by urges to attack, to hide away, to embrace someone, to be comforted, etc. Since all of these action tendencies are associated with physiological changes in the autonomic nervous system (Frijda, 1986), they are probably also reflected in our faces and in the acoustic features of our voices (see Scherer (1986) for specific hypotheses about the effects of appraisals on the physiology of vocalizations). In contrast, less intense emotional episodes and more diffuse affective states such as moods probably have less prominent physiological effects, and therefore, less clear effects on vocal and facial expressions.

Nevertheless, acknowledging that intense emotions involve changes in facial and vocal behaviours should not be taken as implying that every type of emotion is neatly associated with a distinctive pattern of physiological and expressive behaviours, as predicted by the Basic Emotions approach and assumed by the BRECVEMA theory. On the contrary, since every instance of anger, fear, joy, etc. is different, then there is no guarantee that the same action tendencies, physiological changes, and behaviours are present every time we experience these emotions. Consider the following examples from Ortony and Turner (1990): the experience of running into a bear in the woods, sitting in a doctor’s waiting room expecting a diagnosis of cancer, having to answer a difficult question in the context of a job interview, and listening to an eerie sound at midnight in a house where we assumed we were alone. Even though all of these experiences can be considered instances of “fear”, the different contexts in which they occur require us to respond in different ways, and therefore the pattern of physiological activation and the observable behavioural expressions (facial, vocal, postural) would also be different in every case. Furthermore, since emotional responses are always tailored to the demands of the situation, the full pattern of expressive facial and vocal behaviours predicted by Basic Emotion theories are very seldom, if ever, observable in natural circumstances (Barrett, 2006a).

3.3 Does music express basic emotions?

Up to this point, my discussion of the emotional contagion mechanism proposed by the BRECVEMA theory has consisted of demonstrating the problems in the definition of the "Basic Emotion" construct, and in challenging the evidence for patterns of psychoacoustic cues associated with discrete emotions. In this section I return to the question of whether basic emotions are expressed by music. After all, even though the perception of emotion in music may not have its origin in discrete, biologically-hardwired emotions, it is still possible that people perceive musically-expressed emotions in categories that correspond to basic emotions, and that this perception may lead to contagion. My arguments in this second part are organised as follows: first I question the basis for choosing the particular list of basic emotions proposed the BRECVEMA theory. Then I analyse the evidence for cross-cultural perception of musically-expressed emotions, and the evidence from developmental studies. Finally, I analyse the limits of the evidence for the existence of common psychoacoustic patterns in speech prosody and music.

3.3.1 The Basic Emotions Expressed by Music According to the BRECVEMA Theory

The first criticism to the claim that music expresses basic emotions is equivalent to one I presented to the Basic Emotion theoretical tradition in general, as it targets the basis for selecting the emotional categories that are to be considered "basic". For the BRECVEMA authors –and indeed for many other researchers in music psychology (Eerola & Vuoskoski, 2013) - music expresses five basic emotions: Anger, Fear, Happiness, Sadness and Love or tenderness (Juslin, 2013c). These emotions are frequently reported in studies in which participants are asked about which emotions are commonly expressed by music, along with other non-basic emotion categories such as Calm, Peacefulness, Longing, Tension, Solemnity, Loneliness, Desire, and Despair. Furthermore, since most studies investigating perception of musical emotions have concentrated on discrete categories inspired by Basic Emotion theories, there is abundant empirical evidence that the five emotions selected by Juslin and colleagues are reliably recognised by listeners (Eerola & Vuoskoski, 2013). In my view, there are three problems with using these sources of evidence as the basis for determining which emotions music can express. First, asking people which emotions they think music expresses, inform us about their ideas about music expressivity, not about their actual experiences of perceiving music as expressive of emotion (or of other contents). Second, the evidence from experiments on perception of musical emotions involves a circular logic: most researchers assume a priori that music expresses a list of emotions, ask their participants to report their experience using the categories in that list, and conclude that in effect, music expresses the emotions they hypothesised. And finally (and more importantly), the arguments for selecting which basic emotions music expresses should not only be empirical, but also, *theoretical*. To my knowledge, Juslin and colleagues have not proposed a systematic conceptual account of why music should be able to express the set of basic emotions they propose. As a consequence, the BRECVEMA theory has left two crucial questions unanswered.

The first question, as mentioned in section 3.1, is why these researchers have decided to include a category that appears in only a few Basic Emotion theories: *Love-Tenderness*. If the answer is simply that this category appears frequently in the lists of emotions that people more easily perceived in music, then why not include other common categories, such as “peacefulness”? Indeed, research into everyday experiences with music has found that one of the most common affective reactions to music is to feel calm, relaxed (or on in the other extreme, to feel awake and energised) (Juslin *et al.*, 2008; Saarikallio & Erkkila, 2007). Moreover, this finding coincides with other empirical evidence that some of the affective states more frequently reported as perceived in music are calm or peacefulness (Juslin & Laukka, 2004; Lindström, Juslin, Bresin, & Williamon, 2003). In this line of argument, why not assume that ‘calm’ is a “basic emotion”, and that when music makes people feel calm, this happens because of a process of emotional contagion via the activation of a hardwired biological affective program?

The second question, is why out of all the emotions proposed within the Basic Emotions approach, the BRECVEMA theory includes only five categories (Happiness, Anger, Fear, Sadness and Tenderness), in neglect of others categories such as Disgust, Contempt, Guilt, Shame, and Lust (see Ortony & Turner (1990) for different versions of Basic Emotions lists). Perhaps the answer is that the basic emotions included in the BRECVEMA theory are affective states that can be experienced without the need for an object, whereas Disgust, Guilt, Shame and Lust are always "intentional" states, that is, they are experienced directed to an object (e.g. every time we feel guilty, we feel guilty about something in particular). And since instrumental music is characterised by its inability to specify the object of the emotions it expresses, then musical sounds can only express object-less affective states (Cross, 2009; Davies, 2003; Kivy, 1999). Although this might be a sensible argument, the BRECVEMA theory could not adopt it, because it implies that music cannot express emotions but moods, which are the type of affective states that can be experienced without a clear eliciting object. Hence, assuming this argument would ultimately contradict the central assumption of the Basic Emotions framework, which focuses on the phylogenetically inherited character of *emotions* (i.e. quick, object-directed, motivationally driving reactions), not of *moods* (i.e. slow, diffuse, cognitive-biasing states).

3.3.2 Evidence from Cross-cultural Studies

An important prediction derived from the adoption of the Basic Emotion approach by the BRECVEMA theory is that since expression of emotions in music is based on hardwired biological programs, the striking findings about universal perception of facial expressions (reviewed in Matsumoto, Keltner, Shiota, O'Sullivan, & Frank Mark, 2008) should be paralleled in music too. That is, musical systems in the world would use similar acoustic patterns to communicate basic emotions, and therefore listeners across cultures should be able to successfully identify them. Admittedly, just like researchers in perception of facial expressions (Matsumoto, 1989), the authors behind the BRECVEMA theory have acknowledged the existence of cultural variations in the structure of musical systems, and of culture-specific cues to the expression of emotion within those systems. Hence, they have embraced Elfenbein's dialect theory of emotion (Elfenbein, Beaupré, Lévesque, & Hess, 2007), and Thompson and Balkwill's Cue-Redundancy Model (Balkwill & Thompson, 1999; Thompson & Balkwill, 2010) according to which cross-cultural expression and communication of emotion in music is made possible by the existence of both universal and culture-specific cues. The more universal cues are present in a piece of music, the more listeners unfamiliar with a piece of music from another culture can infer the same emotions expressed in that piece as enculturated listeners.

The evidence from cross-cultural studies on perception of musical emotions supports the general hypothesis that listeners are able to identify the intended emotional expression of music from a different culture (Thompson & Balkwill, 2010). What is less clear from this evidence, however, is that cross-cultural perception of musical emotions is organised around basic emotion categories. One reason for this is that some studies have used ad-hoc categories rather than standard emotional adjectives as dependent measures (Deva & Virmani, 1975; Gundlach, 1932, 1935; Morey, 1940). A second reason is that until recently, the studies which have used standard emotional adjectives have only explored the perception of three categories: Joy, Sadness, and Anger (e.g. Fritz *et al.*, 2009), and therefore their results are open to an alternative, dimensional explanation. Thus, since the emotions of Joy, Sadness, and Anger correspond to different combinations of activation and valence levels, (i.e. they correspond to three distinct areas of the two-dimensional affective space, (Russell & Barrett, 1999)), these results make it impossible to discard the hypothesis that the participants' perception is organised around general affective dimensions rather than around discrete categories.

A recent experiment by Laukka and colleagues (Laukka, Eerola, Thingujam, Yamasaki, & Beller, 2013) sought to overcome these and other limitations of past research, such as the tendency to use Western music as the normative stimuli that listeners have to judge. In this experiment, in addition to using Western classical music excerpts, the researchers asked Swedish, Indian and Japanese musicians to create music to express 11 different emotions and affective states (anger, fear, happiness, affection, humour, longing, peacefulness, sadness, solemnity, spirituality, and neutral), which were later judged by listeners from the same three cultures. The researchers also analysed the extent to which musicians and listeners use the same acoustic cues to encode and decode the intended affective expressions. The results from the experiment largely support the researchers' predictions. The listeners were better at identifying basic emotions (anger, fear, happiness, and sadness) than non-basic ones (e.g. solemnity, humour, and longing). And even though they were equally good at recognising the emotional expression intended by Western classical music excerpts, they were better able to identify the intended emotions in music from their own culture than from an unfamiliar one.

Moreover, while musicians and listeners used several similar psychoacoustic cues across cultures to encode and decode emotions, some cues were culturally specific, that is, they were only used by musicians and listeners from the same cultural background.

As can be seen by the description above, Laukka and colleagues' experiment represents an important contribution to cross-cultural studies of music perception. Its combination of the analysis of psychoacoustic cues used by musicians and by listeners, and the increased number of emotions analysed should become the standard method in this research field. Moreover, the findings from this study are certainly encouraging for the hypothesis that music can universally communicate four basic emotions. However, this conclusion can be qualified by the following considerations.

First, the pattern of confusion exhibited by participants, (i.e. the distribution of occasions when they misattributed the intended expression in the music) was consistent with the view that participants were sensitive to the activity and valence dimensions of music.

Second, the acoustic cues associated with the expression and perception of discrete emotions that have the same level of activity and valence show a large number of coincidences. These coincidences, however are more marked across those cues that are common to vocalizations and music (such as intensity, timbre, and pitch height), than across those cues that can only be found in music (such as modality, tonal and rhythmic stability). This suggests that even though the listeners' sensibility to the first type of cues may have helped them identify the level of arousal and valence expressed by the music, the musically-specific cues were critical for the listeners' ability to differentiate emotions with similar levels on those dimensions.

Third, some emotions considered "basic", and therefore universal by the BRECVEMA theory, were not correctly identified above chance levels, sometimes even by members of the same culture. For example, Happiness was only correctly identified in Western classical music and Swedish folk music; Sadness in Japanese music was not recognised by most Japanese listeners, and Sadness in Swedish music was not recognised by most Indian listeners. Affection, the emotion category most closely related to the "tenderness/love" category proposed as a basic emotion by the BRECVEMA theory, was not correctly identified in any of the non-Western musical styles (the only exception was Indian music, were it was identified only by Indian listeners). This finding that several basic emotions were not identified even within listeners of the same culture contrasts starkly with the high accuracy levels exhibited by participants of experiments on cross-cultural perception of facial and vocal expressions (c.f. Scherer *et al.*, 2011).

Finally, of all the musical cultures examined in this study, emotional expression in Japanese music was the least successfully recognised by the participants. This may be part in due to the fact that Japanese music uses fewer acoustic cues that are common to Western, Indian and Swedish music. For example, Japanese music is much more ambiguous in its use of modes, interval sizes, and scales and their association with valence. Japanese music uses combinations of intervals such as 2nd minor, 3rd major, etc. (Malm, 2001, p. 160). Again, this observation highlights the importance that culturally-specific cues have in identifying musically-expressed emotions beyond the general dimension of arousal, which is the dimension most clearly expressed by speech prosody.

In conclusion, the evidence from cross-cultural studies of expression and perception of musical emotions supports the hypothesis that expression of emotions in music is grounded on acoustic cues shared with vocalizations, and that these cues can at least signal variations in levels of arousal and valence. The evidence for universal musical expressions associated with discrete emotions is encouraging, but partial, and it suggests that this fine-grained differentiation might depend more on cues that are present in music, but not in vocalizations. Clearly, further studies using methods such as the one implemented by Laukka and colleagues (2013) are needed to advance in understanding this phenomenon.

3.3.3 Evidence from Developmental Studies

Another crucial prediction from the BRECVEMA theory, in line with the claims of the Basic Emotions theoretical tradition, is that expression and perception of basic emotions appear early in development (Izard, 1992). Hence, it is expected that children's perception of musical emotions should follow the same early developmental path.

The evidence from developmental studies contradicts this assumption. Thus, until approximately age 3, children's emotional vocabulary and perception is organised into broad categories representing the contrast between positive and negative experiences (Widen & Russell, 2008). Infants progressively incorporate more fine-grained categories such as sadness, anger, and fear when they reach the age of 4 or 5 (Bormann-Kischkel, Hildebrand-Pascher, & Stegbauer, 1990; Widen & Russell, 2008). This process of evolution is not clearly paralleled in music. The evidence so far indicates that although children show early signs of sensibility to music, such as their preference for the melodic contours present in infant-directed speech (Fernald, 1985; Werker, Pegg, & Mcleod, 1994), and their perceptual sensitivity to consonance and dissonance (Trainor & Heinmiller, 1998), their ability to categorise emotions expressed by music emerges years later. Their ability to tell the difference between happy and sad music is observable around the same age when they develop the ability to entrain to musical rhythms (more or less 5 years of age), suggesting the central role that tempo variations have in distinguishing these two expressions (Dalla Bella, Peretz, Rousseau, & Gosselin, 2001). Furthermore, children develop the ability to distinguish between happy, sad, angry and scary music at the same age as they develop the sensitivity to mode (6 to 8 years), a musical cue associated with the expression of negative emotions in Western music (Gregory, Worrall, & Sarge, 1996).

3.3.4 Evidence for Shared Psychoacoustic Cues in Speech Prosody and Western Music

The strongest piece of evidence invoked by the BRECVEMA theory for the expression of basic emotions in music is the already mentioned review of 145 studies into emotional expression vocalizations and music carried out by Juslin and Laukka (2003). This evidence, however, is not completely unambiguous. On the one hand, the results of most studies support the prediction that acoustic parameters associated with the expression of emotion in vocalizations show the same patterns of association in music. But on the other hand, the evidence for the claim that the acoustic parameters that *discriminate specific emotions* in music are the same for vocalizations is less clear. In fact, a detailed examination of the data shows that most of the acoustic parameters that discriminate specific emotions in music do not present the same pattern in vocalizations. First, in music, Fear and Anger are distinguished by sound level (high in Anger, low in Fear), but this distinction is not paralleled in vocalizations, where both emotions are associated with high sound level. Second, in music, Happiness is associated with little sound level variability, whereas in vocalizations, it is associated with high variability. And third, in music, timbres characterised by abundant presence of high-frequencies are associated with Anger, timbres with moderate number of high-frequencies are associated with Happiness, and timbres with few high-frequencies with Fear. In vocalizations, all emotions with high levels of activation (Anger, Fear, and Happiness) are associated with abundant presence of high frequencies.

The evidence from Juslin and Laukka’s (2003) review can be complemented by more recently published experiments into shared psychoacoustic cues to the expression of emotions in music and speech (Bowling, Sundararajan, Han, & Purves, 2012; Curtis & Bharucha, 2010; Illie & Thompson, 2006; Scherer *et al.*, 2011; Scherer, Sundberg, Tamarit, & Salomão, 2013; Weninger, Eyben, Schuller, Mortillaro, & Scherer, 2013); and by experiments on musical parameters associated with expression of emotion (Costa, Fine, & Ricc Bitti, 2004; Eerola, Friberg, & Bresin, 2013; Juslin & Lindström, 2010; Quinto, Thompson, & Taylor, 2014; Schubert, 2004). As can be seen in Table 3.1, in general terms this more recent evidence coincides with the results of Juslin and Laukka’s review (2003).

Table 3.1 *Summary of findings of psychoacoustic parameters associated with emotional expression in vocalizations and music published after Juslin and Laukka’s 2003 review*

Cue	Level	Music	Speech
Tempo / Speech rate	High	Joyous, Bright, Restless, Agitated (F&S 2004) High Arousal (Schu 2004) Anger, Fear (Sche 2013) Happiness, Anger (Q 2013; J&L 2010) Happiness (E 2013)	Happiness, Anger, Fear (Sche 2011) Fear (Sche 2013)
	Medium	Anxiety, Despair, Joy, Pride (Sche 2013) Anger, Neutral (Q 2013) Scary (E 2013)	Happiness (Sche 2011) Anxiety, Pride (Sche 2013)
	Low	Low Arousal (S 2004) Serious, Majestic (F&S 2004) Sadness (Sche 2013) Tenderness, Sadness, Fear (J&L 2010) Calmness/ Serenity, Peace, Sadness, Solemnity, Sad, Peaceful (E 2013) Fear, Sadness, Tenderness (Q 2013)	Anger, Sadness (Sche 2011) Anger, Despair, Joy, Sadness (Sche 2013)
Intensity /Sound level	Loud	Restless, Agitated, Tense (F&S 2003) Anger (J&L 2010) Positive Arousal (Schu 2004; W 2013) Anger, Fear (Sche 2013) Anger, Happiness (Q 2013) High Arousal (W 2013) Scary (E 2013)	Positive Energetic Arousal, Positive Tense Arousal (I&T2006) Happiness, Anger (Sche 2011) Anger, Fear, Joy (Sche 2013) High Arousal (W 2013)
	Medium	Anger, Pride (Sche 2013)	Despair, Pride (Sche 2013)
	Soft	Delicate, Graceful, Relaxed, Quiet (F&S 2003) Negative Arousal (Schu 2004; W 2013) Positive Valence, Negative Tense Arousal (I&T 2006) Fear, Tenderness (J&L 2010) Sad, Peaceful (E 2013) Low Arousal (W 2013) Sadness, Tenderness (Q 2013)	Positive Valence, Negative Energetic Arousal, Negative Tense Arousal (I&T2006) Anxiety, Sadness (Sche 2013) Low Arousal (W 2013)

Table 3.1 (… continued) *Summary of findings of psychoacoustic parameters associated with emotional expression in vocalizations and music published after Juslin and Laukka's 2003 review*

Cue	*Level*	*Music*	*Speech*
Pitch / Fundamental Frequency	High	Positive Tense Arousal (I&T 2006) Anger, Fear (J&L 2010) Happiness, Peaceful (E 2013)	Positive Valence, Positive Energetic Arousal (I&T 2006) High Arousal (W 2013) Happiness, Anger, Fear (Sche 2011)
	Low	Negative Tense Arousal (I&T 2006) Happiness, Tenderness (J&L 2010) Scary, Sad (E 2013)	Negative Energetic Arousal (I&T 2006) Sadness (Sche 2011) Low Arousal (W 2013)
Timbre / Relative spectral energy	Bright, Sharp	Anger (J&L 2010) Joy (Sche 2013) Scary (E 2013)	Anger (Sche 2013)
	Medium	Anxiety, Despair (Sch 2013); Happy (E 2013)	Anxiety, Despair, Fear, Pride (Sch 2013)
	Dull, Soft	Sadness, Tenderness (G 2010) Fear, Happiness, Tenderness (J&L 2010) Sad, Peaceful (E 2013) Sadness (Sche 2013)	Sadness (Sche 2013)
Vibrato/Voice irregularity	High	Anger, Fear (J&T 2010) High *jitter* (Vibrato) and high *shimmer* in Anger, Fear, Pride, Joy (Sche 2013)	High Shimmer in Anger, Fear, Joy (Sche 2013)
	Low	Low *jitter* (vibrato) and low *shimmer* in Anxiety, Despair, Sadness (Sche 2013)	Low shimmer in Anxiety, Pride, Sadness (Sche 2013)
Melodic/Pitch contours	Rising	---	Happiness, Anger (Sche 2011)
	Falling	---	Sadness (Sch 2011)
Interval Size /Frequency difference between consecutive syllables	Large	Tritones, Intervals larger than octave = Dynamism, Instability (C 2004) Unison, Octaves = Potency (C 2004) Positive/excited emotion (B 2012)	
	Small	Negative/subdued emotion (B 2012)	Minor third in Sad speech (C&B 2010) Negative/ Subdued Emotion in English Speakers, not Tamil speakers (B 2012)

Table 3.1 (… continued) *Summary of findings of psychoacoustic parameters associated with emotional expression in vocalizations and music published after Juslin and Laukka's 2003 review*

Cue	Level	Music	Speech
Mode	Major	Positive Valence (C 2004, Q 2013) Happiness, Tenderness (J&L 2010, Q 2013) Peaceful (E 2013)	----
	Minor	Negative Valence (C 2004) Sadness, Dreamy, Dignified, Tension, Disgust, and Anger, Fear, Sadness (J&L 2010) Scary, Sad (E 2013) Anger, Fear, Sadness (Q 2013)	----
Articulation	Staccato	High arousal (Q 2013) Fear (J&L 2010) Happy (E 2013) Anger, Fear, Happiness (Q 2013)	----
	Legato	Low arousal (Q 2013) Tenderness, Sadness (J&L 2010; Q 2013) Sad, Peaceful (E 2013)	----
Rhythmic Complexity	*Complex*	Sharp duration contrasts in Happiness, Anger, Tenderness (J&L 2010) Higher rhythmic contrasts for Anger, Sadness, Happiness (Q 2013)	----
	Simple	Soft duration contrasts in Sadness, Tenderness (J&T 2010) Lower rhythmic contrasts for Neutral (Q 2013)	----
Harmonic Complexity	Complex, Atonal, Dissonant	Negative Valence (C 2004) Sadness (J& L 2010)	----
	Simple, Tonal, Consonant	Positive Valence (C 2004)	---
Attacks	Fast	Happiness, Anger (J&T 2010)	
	Slow	Sadness, Tenderness (J&T 2010)	

Abbreviations used in the table:

(B 2012) = Bowling, Sundararajan, Han, & Purves, 2012
(C&B 2010)= Curtis & Bharucha 2010
(C 2004)= Costa, Fine, & Ricc Bitti, 2004
(E 2013) = Eerola, Friberg, & Bresin, 2013
(F&S 2003)= Fabian & Schubert, 2003
(I&T 2006) = Illie & Thompson, 2006
(J&L 2010) = Juslin & Lindström, 2010
(Q 2014) = Quinto, Thompson, & Taylor, 2014
(Sche 2011) = Scherer, Clark-Polner, & Mortillaro, 2011)
(Sche 2013) = Scherer, Sundberg, Tamarit, & Salomão, 2013
(Schu 2004) = Schubert, 2004
(W 2013) = Weninger, Eyben, Schuller, Mortillaro, & Scherer, 2013)

Taken together, the evidence from cross-cultural and developmental studies, and from research into the expression of emotion in vocalizations and music leads to the following conclusions:

1. Just as proposed by the authors of the BRECVEMA theory, there are a great number of coincidences between acoustic patterns in speech prosody and in music. This suggests that the perception of expression of emotions in music and in vocalizations depends, at least partly, in shared psychological and neural mechanisms (Escoffier, Zhong, Schirmer, & Qiu, 2012).
2. Just as found in research into emotional vocalizations in general, most of the parallels between psychoacoustic cues to emotional expression in speech prosody and music can be mapped onto different levels of arousal.

   An exception to these parallel findings is expression of Fear in music, which does not share some of the basic psychoacoustic cues found in emotional speech. However, an analysis of the features of the “fearful” stimuli in most experiments suggests that in this category, the distinction between expressed and induced emotions has been blurred. These stimuli are characterised by low overall sound level and fast tempo, but also with high levels of loudness and tempo variability. This pattern suggests that rather than portraying the subjective experience of a scared person, the sudden variations of intensity in the “fearful” musical stimuli are aimed at scaring the listener with the presence of unprepared, subito-forte sounds and variations in musical speed (c.f. Vieillard *et al.*, 2008).
3. If we limit the analysis to the cues that are both present in prosody and music, it is difficult to find consistent and unambiguous patterns that can be mapped onto variations in valence and/or discrete emotions. At the same time, the more we include cues present exclusively in music (such as modality, and harmonic and rhythmic complexity), the more we find distinct associations between configurations of acoustic cues and the expression of specific emotions.[8]
4. The fewer music-specific cues are present, the more people who not familiarised with them have difficulties identifying the intended expressed

---

[8] An intriguing exception is a study by Curtis and Bharucha (2010), which found that expression of sadness in vocalizations by English participants was associated with pitch variations equivalent to the minor third interval in music. This result was replicated by Bowling *et al.* (2012) with a different sample of English speakers, but not with a sample of Tamil speakers (an Indian language). Hence, further replications with larger samples of languages are necessary before accepting this hypothesis.

emotion in music (i.e. children, and listeners from non-Western cultures). Nevertheless, the analyses of the pattern of misattribution made by participants in the experiments reveals that listeners are sensitive to the levels of activity and valence expressed by music.

5. Conversely, as predicted by Juslin's model (Juslin, 2003), most studies have found that the more cues are present, the more participants can successfully recognise discrete emotions. This finding is equivalent to the conclusions from experiments into perception of facial expressions: the more an expression is portrayed as an exaggerated prototype containing all possible cues, the easier it is for observers to recognise it as expressive of a discrete emotion.

   It is unclear, however, the extent to which the music that people choose to listen in their everyday lives, (as opposed to music used in experimental studies) makes use of these stereotyped acoustic configurations. There is evidence for example, that valence is differently expressed across musical genres (Eerola, 2011); and that attempting to identify excerpts of emotionally-expressive music from film soundtracks, (where one of the functions of music is to bring emotional depth to the visual narrative), implies a laborious process of selection and discarding of potential stimuli (Eerola & Vuoskoski, 2011).

6. The results from some of the reviewed studies contradict the general observed trends, and some contradict Juslin and Laukka's summary (2003). These inconsistencies can be attributed to several reasons. First, there are important differences in procedures, materials, and measurement scales across studies. In particular, discrepancies in the way emotions are labelled can lead to different results. For instance, it is not the same to ask musicians to produce music that sounds angry than to ask them to produce music that sounds frustrated, irritated, or furious; and likewise, these adjectives are not necessarily equivalent from a listener's point of view. Second, it is possible that some of the inconsistencies in the psychoacoustic cues associated with the expression of emotions are due to the presence of interactions between several cues (Eerola *et al.*, 2013; Quinto, Thompson, & Keating, 2013).

7. Just as in the field of vocalizations research, most music investigators have limited their analysis to a few acoustic cues, which they have analysed taking averaged measures of variation (e.g. mean tempo, mean fundamental

frequency, etc.). Therefore, it is conceivable that studying a greater number of acoustic parameters, and analysing the way these acoustic cues evolve in time (rather than using averaged measures) can lead to more fine-grained associations between acoustic cues and discrete emotions. This is a challenge for future research in this field (c.f. Coutinho & Dibben 2012). Nevertheless, it is worth noting that research that has assumed the same challenge in other domains, such as the physiological changes associated with emotional experiences, have not found solid evidence for the expected patterns, even after increasing the number of analysed cues.

3.4 The perceptual paradox

As mentioned above, the best support for the existence of Basic Emotions is the finding that when participants are asked to judge the emotion communicated by a portrayed facial, vocal or musical expression, they agree in the correct answer above chance level[9] (Scherer *et al.*, 2011). This finding, however, entails a paradox: although there is little evidence that the facial and predicted vocal patterns occur in natural circumstances, although it has been difficult to establish patterns associated with discrete emotions (particularly in vocalizations), and although psychoacoustic cues to expression of emotions shared by vocalizations and music are more clearly related to arousal than to discrete emotions, people's perception of these stimuli is clearly organised into categories (Laukka, 2005). Moreover, people tend to agree as to which categories correspond to every stimulus they judge. In other words, whereas *objective* measures of emotional expression have failed to find distinct categories, people's *subjective* perception of emotion is categorical (Barrett, 2006b). As I show in the final section of this chapter, this paradox can be resolved by considering the way cultural and perceptual categories are constructed, and the crucial role that context has in the perception of emotional expressions.

The first of these arguments can be found (surprisingly, given my preceding critique) in a passage of a paper by Juslin (Juslin, 2013c). When confronted with the above-mentioned inconsistency, Juslin concedes that discrete categories exist in people's minds, not in the materials (facial expressions, voices, or music): "it's clear that the

---

[9] Admittedly, this level of decoding accuracy is lower for vocal expressions (around 59%) than for facial expressions (around 77%).

acoustic patterns obtained do not always neatly correspond to categories. But to look for discrete categories in the acoustic data is to look at the wrong place altogether. Categorical perception is *a creation of the mind*, it's *not in the physical stimulus*" (Juslin, 2013c, p. 5 italics added). From my point of view, the importance of this observation is paramount, because it suggests that the findings about universal perceptions of emotions are not due to emotions having a common, discrete biological substrate, but to the existence of common emotion concepts that organise people's perception of emotions. Indeed, the existence of a limited, universal set of emotion concepts in people's perceptual systems and languages need not arise from biologically-predetermined emotions; it can simply occur because all humans across cultures face the same relevant events (e.g. facing a threat, losing something valued, confronting goal-obstructing situations, discovering outcomes that are better than expected, etc.). If all human beings face the same type of goal-relevant situations, and they evaluate them in similar ways, then it follows that all cultures must create similar conceptual and linguistic categories to denote them (Frijda, 2008). Scherer has proposed to call these cross-culturally common emotions, "modal emotions" (Scherer, 1994).

Nevertheless, the existence of these common conceptual and linguistic categories does not completely dissolve the paradox. The existence of cross-culturally shared categories does not explain why, when presented with exaggerated expressions, most participants attribute the *same* emotional category to the same stimuli, and why they still tend to select the correct category when they judge facial, vocal or musical stimuli portrayed by people from other cultures. The answer to this question has two parts, both related to the way people use and construct mental prototypes.

The first part of the answer lies in the fact that caricatured stimuli are easier to categorise than typical stimuli when the categories in question are highly interrelated (Goldstone, Steyvers, & Rogosky, 2003). Thus, even though these exaggerated, caricatured stimuli do not correspond to the most frequently observed expressions in natural circumstances, they have a central place in emotional concepts, guiding the perception of facial and vocal expressions (Laukka, 2005).

The second part of the answer lies in the way people construct ideal representations to categorise similar objects, even when they have never seen an object containing all the features of the ideal representation. Particularly in the case of face recognition, a number of studies have demonstrated that when participants are presented with a number of similar faces, they implicitly build prototypes "averaging" their features, and that these prototypes are so strong that they create false memories of having seen them before (Bruce *et al.*, 1991; Cabeza, Bruce, Kato, & Oda, 1999; Solso & McCarthy, 1981). Thus, in the second part of these experiments, participants are asked to perform a memory task consisting in discriminating new and previously-presented stimuli. The old stimuli consist of the same faces presented in the first part, and the new stimuli are a mixture of completely new faces, and faces created by averaging the features of the old ones. In all of these experiments researchers found that participants report wrongly, but with a high level of confidence, that they remember having seen the new "averaged" stimuli during the first part of the experiment.

The same process of prototype construction probably occurs in perception of emotional expressions, including musical ones: even though the exaggerated emotional expressions used in experimental research are rarely encountered in natural circumstances, they are easily identified because people's perception of emotion is based on categories that use the average prototype as a guide for classification. Additionally, it is also likely that at least in the case of Western participants, these mental prototypes are derived from their exposure to culturally shared images and symbols such as the classic Greek images for comedy and tragedy, the facial and vocal expressions of cartoons, and the associations between visual narratives and music soundtracks.

3.4.1 The Role of Contexts in the Perception of Emotions in Facial, Vocal, and Musical Expressions

A further argument that can help resolve the perceptual paradox is the consideration of the crucial role that contexts play in the perception of emotional expressions; a role that both the Basic Emotion tradition and the BRECVEMA theory have largely ignored. These two theoretical approaches share the implicit assumption that emotional meanings are inherent to facial, vocal, and musical expressions, and therefore they can be readily decoded by perceivers. This assumption is based on an evolutionary argument, according to which, it is adaptive for animals to communicate discrete emotional categories using fixed expressive patterns, which can be recognised by an observer in any circumstance (Ekman, 1992; Juslin & Laukka, 2003).

The problem with this evolutionary argument is that it assumes that expressive gestures and vocalizations always originate in an underlying emotional state, and that they are always perceived as communicating emotions by observers, as if humans and animals ever expressed and perceived emotions in context-free situations. There is, however, evidence that evolution has favoured flexibility over rigidness, and the communication of social intentions over emotional states, even in non-human primates (e.g. Parr, Waller, & Fugate, 2005). This alternative view proposes that it is usually more advantageous for animals (and humans) to use expressions to communicate intentions, rather than to openly show their emotional state (Bachorowski, 1999; Fridlund, 1994). For example, it is more advantageous for a primate to display an expression of anger when it wants to intimidate a rival (thus preventing the confrontation from happening), than when it has the intention of attacking and overcoming its rival immediately (Fridlund, 1994). Similarly, studies with human participants have shown how emotional expressions vary according to the characteristics of the situation, and communicate different intentions accordingly. For instance, people do not necessarily smile more when they experience positive results on their own, but they do smile more when they communicate those positive results to other people (Kraut & Johnston, 1979; Ruiz-Belda, Fernandez-Dols, Carrera, & Barchard, 2003). Also, different types of smiles are associated with different motives. For example, embarrassment smiles seem to have the function of appeasing the negative judgement of observers, whereas enjoyment smiles have the function of increasing closeness with others (Niedenthal, Mermillod, Maringer, & Hess, 2010).

This flexibility of expressions is also evident in the way observers perceive different meanings in facial expressions and vocalizations according to the context in which they occur. Several experiments on perception of emotional expressions have demonstrated this effect (see Barrett, Mesquita, & Gendron, 2011 for a review of the evidence). For example, Carroll and Russell (1996) showed how even exaggerated portrayals of emotions can be perceived as expressing different emotions, or even non-emotional states when they are associated with different contexts. For instance, when participants observed a face showing the prototypical anger expression, they perceived it as alternatively expressing anger, fear, or physical exertion, depending on the type of narrative that they read about the situation that led the person to make that facial expression.

A defender of the Basic Emotion approach could reply to this argumentation saying that in a psychological experiment, the participants who judge the portrayed stimuli encounter them in a context-free situation. Yet this argument can be challenged by considering that in these experiments, the context is provided by the list of emotional adjectives that the participants have to choose from to make their judgement. These lists effectively restrict the number and type of inferences that participants can make about the psychological state of the person portraying the expression, and therefore bias their perception of it (Frank & Stennett, 2001; Russell, 1994). Research has shown that when instead of close-ended questionnaires, investigators use open answers, or tasks asking participants to match two faces expressing the same emotion, agreement among participants diminishes dramatically (Russell *et al.*, 2003).

In the context of music, the biasing effect that response formats have on perception was demonstrated in an experiment by Watt and Ash (1998), where instead of asking listeners to rate the emotion expressed by the musical stimuli, the researchers asked them to rate the extent to which the music portrayed traits generally associated with a person, such as gender (male/female), age (young/old), and friendliness (good/evil). The high levels of agreement observed in the participants' answers suggest that they readily used these categories to make their judgments. These results also suggest that musical meanings, just like facial and vocal expressions, are flexible, not inherent to the musical materials, and not restricted to a few standard emotional categories.

This observation that people's perception of meanings in music is flexible and varies according to different listening contexts has two larger implications for research into musical emotions. On the one hand, this perceptual flexibility suggests that finding that listeners *can* identify discrete emotions in music, does not suggest that people usually engage with music with the objective of perceiving emotional contents. Moreover, people's ability to perceive discrete emotions in music does not suggest that when people perceive emotions expressed by music, they experience them as discrete categories, or that the categories they perceive correspond to the discrete emotional adjectives that experimental research has investigated (Clarke, 2014). On the other hand, acknowledging people's perceptual flexibility in relation to music implies that a central question that researchers of musical emotions should address is: what are the circumstances under which emotional meanings are privileged over non-emotional ones? This question, of course, cannot be satisfactorily answered by psychological theories that regard musical communication phenomena exclusively in terms of processes of encoding and decoding of acoustic information from musicians to listeners (Juslin, 2003).

In summary, in these two last sections I have shown how the perceptual paradox, consisting of the inconsistency of findings from objective and subjective measures of emotional expression, can be resolved by considering that the categorical perception of emotional expressions emerges from: a) the existence of common linguistic categories, b) the construction of ideal representations which create the illusion of the existence of prototypical expressions in natural circumstances; and c) the disambiguating effect that contextual information has in the perception of emotional expressions. Thus, I submit that there is no need to invoke the existence of hardwired basic emotions to explain how people perceive categories in vocalizations and in music, as claimed by the BRECVEMA theory.

3.5 Conclusion

In this chapter I argued that the theory of emotional contagion with music proposed by the BRECVEMA theory faces several difficulties, all of them related to the problems with its adoption of the concept of Basic Emotions and the empirical evidence for their existence. The main argument I proposed is that although there is evidence for the claim that the expression and perception of musical emotions arises from mechanisms that are shared with the expression and perception of speech prosody, this common biological ground is not organised around discrete categories. Instead, I submit that the evidence so far suggests a dimensional interpretation. In other words, the acoustical cues present in music can at the very least, be mapped onto variations of activation and valence. Moreover, due to the fact that listeners across cultures are sensitive to these underlying dimensions, they can express and perceive a wide variety of emotional and non-emotional meanings in music.

It is important to note that my arguments do not amount to saying that musical meanings are completely free, idiosyncratic, and as variable as the contexts in which they occur. On the contrary, drawing from an ecological perspective to music perception, my claim is that musical structures *afford* certain meanings to be privileged over alternative ones. In this approach, emotional meanings emerge from the complex interaction of the objective qualities of the music (i.e. the variations associated with activation and valence levels), the psychological state, abilities, and motivations of the listener, and the cultural and situational context in which the musical event takes place (Clarke, 2005; Dibben, 2001).

This individual and contextual variability is to some extent acknowledged in Juslin's theory of musical expressivity. According to this model, the three layers of coding make it possible that music expresses basic emotions, and other non-basic emotions or affective states such as hope, solemnity, spirituality, etc. (Juslin, 2013c, pp. 9–10). The problem I see with this theory is that it leaves several crucial questions unanswered:

- If people can easily perceive basic and non-basic emotions in music, what are the conditions under which people perceive basic emotions, and what are the conditions under which they perceive other emotional and non-emotional meanings?
- On occasions where non-basic emotions (or other meanings) have priority in the listener's conscious experience, is it still possible that some brain mechanism detects the underlying basic emotion expressed by the music in the iconic layer, and triggers the emotional contagion mechanism?
- How clear does the expression of a basic emotion have to be for this process of contagion to be triggered? In other words, does it depend on the presence of a clear, stereotyped combination of acoustic cues in the music?
- How does the brain decide whether to give priority to the information provided by the contagion mechanism, or to the information provided by other simultaneously activated mechanisms of emotion elicitation?

Finally, I deem it necessary to point to two important areas of coincidence and difference between my proposal and the BRECVEMA approach:

In the first place, the approach here proposed complements, rather than replaces the lens model proposed by the authors of the BRECVEMA theory. The lens model, with its strong emphasis on the process of encoding and decoding of psychoacoustic cues, finds it hard to explain how it is possible that people can identify the correct emotional expression when there are few cues present in the musical material, and/or when they are not perceived by listeners. From my perspective, this paradox is easily resolved by considering the role of contexts in the construction of musical meanings. Thus, contextual information such as the social significance of the occasion, the song's lyrics, the presence of visual narratives, the musicians' gestures, and the listener's psychological dispositions can lead to the perception of emotional and non-emotional meanings in the music even when the musical materials are ambiguous.

Second, a point of departure from Juslin’s approach is that I consider it unnecessary to propose the existence of three layers of coding for explaining the perception of musical emotion: an iconic level based on basic emotions, an intrinsic coding level that communicates fluctuations of tension, and an associative level that communicates “arbitrary” associations (Juslin, 2013c, p. 4). I find it more parsimonious to dispose of the idea that the iconic level denotes discrete basic emotions, and to assume that music communicates fluctuations of valence and activation that can be mapped onto many possible meanings via association mechanisms. This is one of the basic premises of the constructionist approach to the induction of musical emotions that I present in next two chapters.

4. Principles of constructionist theories of emotion

I dedicate this chapter and the next to present my theoretical proposal about how musical emotions are elicited. The aim of this proposal is to overcome the shortcomings that I identified in contemporary theories in the first three chapters, based on the consensual definition of emotion I presented in Chapter 1, and on the principles of social and psychological constructionist theories of emotion[10] (e.g. Averill, 1980; Barrett, 2006; Cunningham & Zelazo, 2007; Harré, 1986; Ortony, Clore, & Collins, 1988; Russell, 2003). I describe the main principles of constructionist approaches, and I explain how these approaches explain the process of emotion elicitation, making emphasis on Barrett's Conceptual Act Theory. In the next chapter I explain how these principles can be adapted to account for the phenomena of perception and induction of musical emotions.

4.1 What is a constructionist approach to explaining emotions?

In general terms, adopting a constructionist approach means assuming that a given social or psychological phenomenon is constituted by an assemblage of more basic elements (Faucher, 2013). In both sociological and psychological constructionist approaches this assumption implies that the observed phenomena (e.g. notions of gender, race, social conflict, etc., or mental skills, emotions, musical meanings, etc.) are

---

[10] Some authors consider the terms "constructivism" and "constructionism" as equivalent (e.g. Cunningham 2013, Faucher 2013). In this thesis, I prefer the second term, in order to distinguish theories of emotion from theories of cognitive development such as Piaget's (1980), which are traditionally called "constructivist".

not imminent and exclusively determined by structural and biological conditions (e.g. skin colour, income inequality, brain structures, or acoustic parameters), but emerge from the interaction of more basic processes. Whereas social constructionist approaches emphasise that the human behaviour phenomena result from social interaction (Averill, 1980; Berger & Luckmann, 1966; Harré, 1986), psychological approaches emphasise that mental phenomena are engendered by the interaction between basic psychological processes (Cunningham, 2013). This focus on interaction also entails the prediction that social and psychological phenomena vary considerably depending on the particular interaction that takes place in a given historical, cultural, social and/or personal context.

This emphasis on situational variability and the rejection of biological determinism has always placed psychological constructionist theories of emotion in opposition to the claims of Basic Emotion theories. Starting with the discussion between James' (1890) and Darwin's (1872) theories, every constructionist theory in the last hundred years has emerged as a response to theories that regard human emotions as biologically predetermined categories associated with specific behaviours, physiological patterns, and brain structures (Lindquist, 2013).

Besides the central assumption that emotions are emergent processes that occur when information from the body is interpreted in relation to the characteristics of the external context (Gross & Barrett, 2011), contemporary constructionist approaches hold the same epistemological principles that have been central to this theoretical tradition, and which can be summarised as follows (Barrett, 2013):

The Principle of Variation. Instead of treating variation in the observed behaviours, physiological or neural patterns as measurement errors, constructionist approaches predict, and aim to explain the observed variation. Emotions are considered situated affective states that change in time, according to the demands of the context and the goals of the individual. This assumption implies three predictions. First, a variety of observed behaviours, physiological changes, and brain dynamics can be associated with the elicitation of different instances of the *same* emotional category (e.g. fear of physical harm vs. fear of speaking in public). Second, identical behaviours, physiological and neural responses can be present in different categories (e.g. fear, anger and sadness). Third, emotion categories vary across cultures and across individuals, depending on the way a society, or a person has structured their knowledge about emotion.

The Principle of Core Systems. All constructionist theories propose that emotions emerge from the interaction of core-systems that are not specific to any emotion category, or even to the domain of emotion. Although each theory proposes slightly different core systems, all theories coincide in that emotions emerge when the changes in these core systems are meaningfully related to a situation in the world.

The Principle of Emergentism and Holism. Constructionist theories share the notion that emotions, considered as whole systems, have properties that are not evident in their individual parts. And conversely, they propose that it is not possible to understand how one element of the whole system works without considering how it relates to the rest of elements, and the state of the system as a whole.

4.2 How emotions are elicited according to constructionist theories

4.2.1 The Concept of Core Affect

At every waking moment, our brain automatically integrates information coming from the senses with information stored in memory in order to create a coherent percept of what is going on, and to predict what is going to happen next (Barrett & Bar, 2009; Kveraga, Ghuman, & Bar, 2007). This dynamic of constructing a present experience combining prediction and memory does not consist of a cold cognitive process. On the contrary, affective evaluations of the situation occur so early in perception, that they are involved in the process of knowing “what is out there” and “what is going to happen next” in the world. There is evidence that brain areas associated with evaluating the relevance and value of objects for our well-being (such as the orbitofrontal cortex and the amygdala) receive information from sensorial areas as early as 80ms after the presentation of a stimulus, (even before the stimulus is consciously experienced) (Duncan & Barrett, 2007; Kveraga *et al.*, 2007). Moreover, this process of integration of sensorial information with information stored in memory, and of affective evaluation happens in successive “waves” of neural activation from the sensorial areas of the brain to areas involved in affective evaluation and back, suggesting that each new iteration of the process contributes to the process of refining of the initial perceptual and affective predictions (Cunningham, Zelazo, Packer, & Van Bavel, 2007).

This conceptualization of perception as a process of prediction and sensory-affective integration has three important consequences. First, since the output of this process is not only cognitive but also affective, we are always in an affective state. Although we do not always reflect about it, there is always an affective tone underlying our experience of the present situation (Russell & Barrett, 1999). Second, cognition and affect are intrinsically related, because our affective and motivational states bias our experience of the world, and vice-versa. There is for example evidence that amygdala responses are modulated by the motivational state of the individual: LaBar and colleagues (2001) compared participants who were hungry with participants who were satiated, and found that the amygdala became more activated by the presentation of food-related stimuli in the hungry participants. Third, if affective, cognitive and motivational contexts bias our perception of every situation, then it does not make sense to assume that affective responses occur in a sequential way, starting with the detection of a completely “novel” stimulus, as claimed by appraisal theories (Lazarus, 1966; Scherer, 2009a; Smith & Ellsworth, 1985), and as reflected in the procedure of most emotion experiments.

The underlying affective tone that is constantly present in our waking life is called by Russell and Barrett (Russell & Barrett, 1999) *core affect*. This system is available to consciousness, especially when extreme or urgent changes in our homeostasis capture our attention and motivate us to engage in introspection. When it reaches consciousness, core affect is experienced along two dimensions: *valence*, that corresponds to feelings that we and/or the situation are pleasant, good, inviting, etc. or unpleasant, bad, aversive; and *arousal*, that corresponds to feelings of being activated (i.e. awake, energized) or deactivated (i.e. sleepy or tired) (Russell & Barrett, 1999). Since core affect integrates information from the world and from the body, fluctuations in this fundamental affective system are caused by multiple causes: external stimulation (such as sudden sounds, or changes in the temperature of the environment), bodily processes (such as muscular pain, accelerated heartbeats, hormonal secretions, circadian rhythms, etc.), and psychological processes (such as learned conditioned responses, imagination, and thoughts) (Russell, 2003).

Core affect can be thought of as an embodied and pre-reflective representation of our immediate relation to the environment. It constantly signals whether the situation is safe, helpful, rewarding, threatening, etc. (Russell & Barrett, 1999). Therefore, core affect underlies all the affective responses described in Chapter 1. When core affect is experienced only at the level of primary consciousness as a free-floating affective tone, it corresponds to the mood category. When it is experienced as the inviting or repulsive property of an object, it corresponds to a basic category called differently by several authors: preferences, proto-affects, or automatic affects (Baumeister *et al.*, 2007; Ortony *et al.*, 2005; Scherer, 2000). And when core affect is experienced as intense and caused by an object, it corresponds to the emotion category.

4.2.2 How do Emotions Become Differentiated?

I have explained so far how our affective life is constituted by an ever present underlying state called core-affect. In this section I explain how this fundamental affective state is transformed into discrete emotional episodes. I describe Barrett's Conceptual Act theory in more detail because, as will be evident below, it integrates and further develops the proposals from other constructionist theories.

In Russell's theory (2003), core affect is transformed into specific emotions thanks to a process of attribution that occurs *after* the changes in core affect are perceived. Much like James' (1890), and Schachter and Singer's (Schachter & Singer, 1962) theories, Russell's model consists of two steps: a first step in which an antecedent event causes a change in core affect, and a second step in which the person attributes that change to the antecedent event (i.e. the object of the emotion). On most occasions, the event and the changes in core affect are so salient that the attribution is done quickly and automatically. But on other occasions, either core affect or the object is less clear, and the attribution process is done slowly, involving deliberate inferences. In both cases, even after the change in core affect is attributed to an object, the process of assessment of the object continues in aspects such as its relevance to the person's goals, its causal antecedents, the formation of a plan to deal with the situation, etc. (Russell, 2003, p. 150).

For Clore and Ortony (2008) emotions occur when undifferentiated affect is transformed by appraisal. Unlike Russell, Clore and Ortony do not explain this process of transformation as depending only on attributing an object to the affective changes, nor do they consider that cognitive appraisals occur only *after* this attribution has been made. In their view, the undifferentiated affective reactions are *progressively* shaped into specific emotions by appraisals (Clore & Ortony, 2013). When affect is cognitively elaborated as an emotion, the psychologically relevant situation is redundantly represented in multiple modes at the same time: experiential, cognitive, and behavioural (Clore & Ortony, 2008). The critical role that Clore and Ortony assign to cognitive evaluation makes their theory very close to appraisal models[11]. Nevertheless, the main difference between their model and appraisal theories is that they view appraisal as a process of *interpretation* of the situation and of one's affective response, and not as a sequence of cognitive checks that trigger specific emotions according to a predetermined set of rules.

Cunningham and colleagues (Cunningham *et al.*, 2013, 2007) propose a similar account of the process of transformation of affect into emotion, but the focus of their theory is on the neural processes involved. According to these authors, any new stimulus (internal or external) is initially evaluated in terms of its valence and relevance, resulting in a basic affective state. Whenever the new affective state does not match the brain's prediction, a sequence of more nuanced evaluative processes is initiated, in which the information about the situation and the body is interpreted and re-interpreted in iterative cycles. The first iterations are produced by subcortical areas of the brain such as the amygdala and the ventral striatum, and result in unreflective motivational behaviours such as approach or avoidance. If the increased state of entropy provoked by the discrepancy between the prediction and experience is not resolved at this point, the situation continues to be re-interpreted in further iterations. These subsequent iterations involve progressively cortical areas of the brain such as the prefrontal cortex, and integrate more complex information such as rules and goals. For Cunningham and colleagues, there is no final state to this process, but the more the situation is cognitively elaborated, the more we experience our present situation as an emotion.[12]

Barrett's Conceptual Act Theory (Barrett, 2006) shares the basic assumptions of the other constructionist theories so far described. Specifically, her theory builds upon Russell's (2003) conceptualization of emotions as constituted by two factors: core affect and categorisation, but in her model, categorisation of core affect does not happen *after* a change in core affect is detected. In Barrett's model, core affect and categorisation are processes that *continuously* influence and constrain each other producing a variety of psychological states, among them, emotions (Barrett, 2006; Lindquist & Barrett, 2008).

---

[11] Indeed, in some classifications of emotion, such as Moors' (2009), Clore and Ortony's model is included in the "appraisal theories" category.

[12] These authors also consider that sometimes additional iterations do not lead to more complex evaluations of the situation. Such is the case of rumination, where a dominant representation is repeated over and over without incorporating new useful information.

Barrett calls the process of categorisation of core affect a *conceptual act*, in order to emphasise the immediacy of the process, and its dependence on the existence of previously acquired knowledge, that she regards as “conceptual”. Thus, a conceptual act consists of a quick dynamic of summoning top-down knowledge from similar previous emotional experiences (i.e. concepts), which are integrated with the current sensorial and affective information, creating the emergent gestalt that is an emotional episode. This process is usually so quick that it escapes consciousness (it happens within 150ms), and is experienced as effortless, automatic, and involuntary.

Similarly to Russell’s “attribution” construct, Barrett’s conceptual acts provide the present affective state with an object and a label. However, in Barrett’s model (as in appraisal theories), a conceptual act also integrates knowledge about the cause of the situation, its relevancy for the person’s goals, what is likely to happen next, what their behavioural reaction should be, etc. The difference between Barrett’s theory and (many) appraisal theories is that most appraisal theories regard this knowledge as organised into patterns that are common to all instances of an emotional category (Moors 2014) e.g. all episodes of fear involve evaluating a situation as dangerous and ourselves as defenceless. In contrast, Barrett proposes that the conceptual knowledge that is brought to bear in the construction of an emotional episode is tailored to the needs of the person in a given context (Barrett, 2006).

One crucial consequence of this context-specificity of emotional knowledge is that different instances of the same emotional category do not necessarily share the same observable features: the feelings, expressive behaviours, action tendencies and patterns of neuro-physiological activity will vary according to every situation. For instance, the conceptual knowledge brought to deal with a situation in which we fear a dog barking at us, is different from the knowledge brought to deal with a situation in which we fear having to perform in front of an audience. However, at the same time, this variety does not imply that there are as many types of fear as there are frightening situations and people who experience them. On the contrary, according to the Conceptual Act Theory, we consider these diverse experiences as belonging to the same category because our culture labels them with the same word. Consequently, emotional linguistic terms play the crucial role of organising personal emotional knowledge into socially-shared discrete categories (Gendron, Lindquist, Barsalou, & Barrett, 2012).

Two further differences between the Conceptual Act Model and other theoretical approaches are the assumptions it makes about the type of psychological processing and the format of representations involved in emotional phenomena. Instead of emphasising rule-based processing as do appraisal theories, the Conceptual Act Theory proposes that on most occasions, conceptualization of core affect occurs through top-down, associative processes. The emotional significance of the situation is in great part produced by quickly reinstatement of information from similar conditions in the past (i.e. heuristic or associative processing), rather than by a sequence of checks about the object's relevance for the person's goals and norms (i.e. rule-based processing). Regarding the format of representations, the Conceptual Act Theory draws from grounded cognition theories such as Barsalou's (2003) to propose that information about emotional events is stored in the brain as modal, embodied representations. Concepts are not "abstracted from sensorimotor events and stored in some sort of propositional form, like in an encyclopaedia" […]; instead they are "partial re-enactments or simulations of the sensorimotor states that occurred with previous instances of the [emotional] category" (Barrett, 2006, p. 33). These re-enactments are multimodal (visual, auditory, olfactory, introspective, etc.).

Finally, the Conceptual Act Theory posits that besides core affect and conceptualization, a third core system is involved in the construction of emotion: controlled attention. The role of attention is to shape conceptualization by resolving conflicts between competing representations, and by inhibiting automatic prepotent responses when necessary (Barrett, 2011). Furthermore, in line with Lambie and Marcel's theory of emotion consciousness (2002), the Conceptual Act Theory proposes that when the locus of attention is on ourselves, we tend to conceptualise the changes in core affect as property of the self, resulting in a reflective or self-focused emotional experience (e.g. "I am afraid", "I am angry"); and when attention is focused on the external situation, we tend to conceptualise the changes in core affect as a property of the world (e.g. "this situation is threatening", "this person is offensive") (Lindquist & Barrett, 2008).

4.3 Conclusion

In this chapter I have outlined the main principles of psychological constructionist theories, and I explained how they account for the process of emotion elicitation. To conclude, I find it useful to note the compatibility of recent theories of musical meaning and musical emotions with those principles, as summarised below.

Writing from a musicological perspective, Cook (2001) refutes the notion that musical meanings are embedded in musical works, and proposes instead that musical meanings emerge from the interaction of the material constraints of the sounds, and the context in which the musical performance is received. This notion of musical meaning as emergent and context-dependent is also present in the ecological perspective to musical listening proposed by Clarke and colleagues (Clarke, 2005; Dibben, 2001; Windsor, 2004) who propose that our perception of music is not determined exclusively by our sensorial system nor by the physical characteristics of the sounds, but arises from the interaction of our interests and skills in the present situation, and the structure offered by the sounds.

The sociological perspective offered by DeNora (2000) also shares this view of music as a physical and cultural object that *affords* (rather than *carries*) meanings. DeNora shows in her ethnographic studies how people use music as a resource for constructing subjective states and identities and for modifying their social circumstances.

Regarding emotional experiences with music, the constructionist notion that emotions are constructed from bodily feelings that become emotions given an appropriate context is found in a passage of a paper by Sloboda. In a discussion about the nature of physical reactions to music such as tears, shivers down the spine and accelerated heartbeats, he suggests that “these sensations or feelings are not specific emotions, although they may easily give rise to specific emotions if appropriate contexts or associations are at hand” (Sloboda, 1998, p. 27).

5. A constructionist theory of musically-induced emotions

In this chapter I introduce a theory of induction of musical emotions, grounded on the constructionist principles outlined in chapter four. In a nutshell, my proposal consists in that in any music-listening situation, some features of the sounds are processed quickly and automatically by perceptual processes, producing fluctuations in core affect. On most occasions, these fluctuations are experienced as low-intensity changes in mood, or as non-cognitively sophisticated affective responses such as preferences. On other occasions, the confluence of factors in the music, the person, and the context activate associative and appraisal processes which conceptualise the situation as personally-relevant, producing the emergence of an emotional episode.

This proposal integrates and reinterprets many of the claims of the BRECVEMA theory and the Multifactorial Process Model (Juslin, 2013a; Scherer & Coutinho, 2013). Just like those theories, my proposal is concerned with the psychological processes involved in the induction of musical emotions, rather than with the neural structures that support them[13], and with circumstances of individual music listening, rather than with circumstances of collective listening, or of music making.

This chapter is organised as follows: first, I present the premise that music perception is at the same time a process of prediction and affective evaluation supported by embodied mechanisms. Then, I show how this perceptual process produces changes in core affect, and I discuss the extent to which these changes can be mapped onto two or

---

[13] In terms of Marr's classification of levels of analysis (1982), my proposal deals with the computational level, which identifies the task that a mental system is designed to perform, and with the algorithmic level, which specifies the mechanisms by which information is processed in order to perform the task, but not with the implementation level, which describes how the information is processed in brain structures and circuits.

more dimensions. Next, I explain how conceptual mechanisms transform core affect into discrete emotional episodes, and I explain the role of attention in shaping affective responses to music. Finally, I formulate ten empirical predictions derived from this theoretical framework.

5.1 Musically-induced changes in core affect

5.1.1 The Premises: A View of Music Perception as Affective and Embodied

A starting point to understand how music impacts core-affect is to go back to the notion that perception is a process of prediction, affective evaluation, and integration (see section 4.2.1 of the previous chapter). Hence, perceiving music, just like perceiving any other event in the environment, consists of a constant process of detection of new sounds, prediction of what the next sounds are going to be, a process of affective evaluation of the accuracy of the predictions (Huron, 2006; Meyer, 1956), and a process of evaluation of the significance of the sounds for the person's well-being. The results of this process are, therefore at the same time, cognitive and affective.

A second premise is the embodied character of the representations involved in perception of music. Drawing from grounded cognition theories such as Barsalou's Perceptual Symbol Systems (2003) and embodied cognition theories of music perception such as Leman and Maes' (Leman & Maes, 2014), I submit that perception and cognition of music do not consist of a dynamic of "disembodied" information processing in which acoustic information is translated into abstract symbols (e.g. Krumhansl & Castellano, 1983). Instead, I propose to embrace the notion that all psychological processes, (including mental operations that do not imply overt motor activities), are influenced by the body's morphology, sensory systems, and motor systems (Glenberg, 2010). In this view, even "mental" operations such as perception and cognition are supported by analogical, modal-specific representations. This implies that perceiving music, thinking about music, and having an emotional experience with music all involve partially re-activating the same neural activity in sensorimotor areas of the brain that was present in similar experiences with music in the past. This process of reactivation is called "embodied simulation" in these theories.

Adopting the two premises described above implies regarding musically-induced core affect as a sort of “resonance” or “attunement” of our brains with the structural and affective qualities of the music. Three further arguments can be presented to elaborate this notion of *resonance*.

First, ecological theories of perception of music (Clarke, 2005; Windsor, 2004) propose that our perception of music arises from the interaction of the affordances of the musical sounds, and our capabilities, learning history, and present needs. Additionally, these theories regard perception as intrinsically linked to action: we perceive objects and events in the environment as informing us about not only about “what is out there”, but also about “what we can do about it”. Hence, it can be inferred that listening to music evokes states of action readiness (Frijda, Kuipers, & ter Schure, 1989), which are manifested in our bodily and affective state. These states of action readiness have an impact on our core affect even on those occasions when they are not conscious, or when they are not acted out.

A second argument for the existence of a bodily resonance to music can be found in theories of embodied music cognition such as exemplified by Leman and Maes (2014), Cox (2011), and Overy and Molnar-Szakacs (Molnar-Szakacs & Overy, 2006; Overy & Molnar-Szakacs, 2009). According to this theoretical approach, perceiving musical sounds involves simulating (i.e. internally mirroring) the motor actions, gestures, and/or melodies produced by the musicians. These simulated actions can therefore impact our core-affect. Although this simulation process is in great part implicit, it can also give rise to action tendencies and overt behaviours such as pretending to play the instruments one listens to[14].

Finally, from a micro perspective, Large and colleagues have proposed that music perception arises from patterns of nonlinear neural resonance to the periodicity of musical events (Large & Almonte, 2012; Large & Kolen, 1994). According to this theory, the dynamic characteristics of these neural patterns underlie behavioural and perceptual responses to music (such as motor entrainment and tonal expectations). Moreover, Flaig and Large (2014) propose that these musically-induced neural resonance can communicate core affect by modulating the person’s activation (via increases in tempo and intensity), and by modulating the person’s valence (via violation of musical expectations).

---

[14] In Chapter 7, I describe with more detail these theories of embodied simulation, and I present new evidence for the role of this mechanism in the elicitation of musical emotions.

5.1.2 Processes and Mechanisms that Lead to Changes in Core Affect I: Arousal

The constructionist theory I propose entails identifying two types of psychological mechanisms that become activated when we listen to music: first, those mechanisms that produce changes in core affect; and second, those mechanisms that transform core affect changes into full-blown emotions. In this section I describe the mechanisms that produce changes in core affect, starting with those that produce changes in physiological and experienced arousal. In the next section, I describe the mechanisms that produce changes in valence.

The mechanisms that create fluctuations in core affect are inevitably activated every time we listen to music (even when it is not the focus of our attention), because they make part of the systems that we use to perceive and adapt to the world in any circumstance. These “core-affect mechanisms” produce perceptual gestalts and low-level embodied affective evaluations of the music and the self. As will be evident below, this approach to affective responses to music involves reconceptualising some of the mechanisms that Juslin (2013a), Scherer (2013), and other authors have proposed.

First, from this perspective, the mechanisms of **musical expectancy**, **rhythmic entrainment,** and **Brain Stem Reflexes** (Juslin & Västfjäll, 2008) can be thought of as arising from the same underlying processes of perceptual integration, so that they are ultimately, the same phenomenon observed at different neural and time-scales. They all involve process of neural and bodily resonance (i.e. sensorimotor processing), generation of percepts, predictions of the immediate sensorial future, and appraisals of the success of those predictions.

Starting from a neural perspective, recent research has discovered that listening to music automatically induces nonlinear time-locking synchronization of neural oscillations onto the periodicity of the events in the music (Large, 2008; Lerud, Almonte, Kim, & Large, 2014). This neural resonance interacts with top-down information from similar musical experiences, generating predictions about how the music will unfold.

One way affective information is integrated into this process of perceptual construction is the activation of quick processes of appraisal, where the goal is to predict how the music will continue. Thus, successful predictions are rewarded, reinforcing learning, and unsuccessful predictions are penalised, producing corrections in further predictions (Carver & Scheier, 1990; Colling & Thompson, 2013; Huron, 2006). The affective responses generated by this process of appraisal can usually only be detected in variations in neuroelectric activity, and in peripheral physiological responses such as skin conductance and heart rate variability (Koelsch *et al.*, 2008). However, on occasions the violations of expectations are large enough, and produce fluctuations in core affect that are experienced as changes in experienced arousal, and to a lesser extent in valence (Egermann *et al.*, 2013; Steinbeis *et al.*, 2006). A second, and parallel process that integrates affective information into the formation of musical percepts is the evaluation of the significance of the auditory stimulus for the person's well-being. I return to this point later.

How does the body enter this picture? There are several ways to answer this question. The first way of thinking about the role of the body in the musical expectancy and rhythmic entrainment mechanisms is by moving up one level in the brain architecture, to consider how music listening not only induces neural synchrony, but evokes **motor action plans** too. Colling and Thompson's theory (2013) offers this perspective. In their view, the same motor neural network underlies perception and performance of music (Bangert *et al.*, 2006; Grahn & Brett, 2007; Wilson & Knoblich, 2005). Therefore, whenever we listen to music, mirror neuron systems generate action plans in motor areas of our brain, as if we were about to produce the musical sounds ourselves. In this sense, these simulated action plans can be considered as the motor counterpart of the predictive neural oscillations described in the previous paragraphs.

The simulated action plans evoked by music listening also generate embodied sensations and changes in core affect. They are on occasions subjectively experienced as the feelings of tension that Huron (2006) associates with the anticipation of events in the music (i.e. the Tension phase of the ITPRA dynamic). On other occasions, such as when the musical rhythm violates a moderate number of expectancies, the action plans are subjectively experienced as an urge to move along with the music (Witek *et al.*, 2014). Moreover, the constant process of appraisal of prediction success adds up to these bodily sensations, generating further fluctuations of core affect. Again, the level of accessibility to conscious awareness of these fluctuations depends on how large the deviations from the predictions are. Since most of the times the music that we listen to is predictable, and violates a moderate number of expectations, the fluctuations in core affect are fleeting and non-conscious, and thus only detected by physiological measures of arousal such as skin conductance responses, or as feelings of increased tension or "emotionality" in the music (e.g. Steinbeis *et al.*, 2006). At other times, these fluctuations are larger and experienced more consciously as feelings of discomfort (i.e. negative valence), or as experiences of surprise.[15]

A second way of answering the question about the effects of music perception on bodily states is by moving up an additional level in the biological hierarchy, to consider how patterns of bodily tension arise from **primitive mechanisms of adaptation** of the whole organism to the environment. This means that we do not only process music as sounds that can be organised into musical gestalts such as melodies, harmonic progressions, rhythmic sequences, etc. We also process music as acoustic information that specifies events in the world (Clarke, 2005). Thus, from this ecological perspective, it is conceivable that on a primitive and mostly preconscious level, musical events are appraised as providing signs that an event is safe or dangerous, that an object is approaching or moving away from us, the level of physical strain from the person making them, etc. Moreover, from this perspective, perception is regarded as a process of preparation for action, and therefore detecting this kind of information may also provoke patterns of bodily and mental activation, such as changes in muscular tension, changes in heart and respiratory rate, re-orienting of attention, and so on.

Research on perception of musical tension can be interpreted as offering support to this hypothesis that bodily responses to music arise in part from adaptation responses. Investigators such as Illie & Thompson (2006), Granot & Eitan (2011), and Farbood (2012) have found that increased dynamics, faster or accelerating tempi, higher pitch register, and rising melodic contours are associated with higher ratings of perceived tension (as compared with the opposite patterns). For Granot and Eitan (2011), these experiences of tension are originated in evaluations of the acoustic events as specifying the presence of dominant, large and powerful objects (or their opposite), which in consequence, evoke the corresponding alarm or relaxation responses in the listener. Although this line of research has focused on perceived, rather than on induced tension, it can be argued that these two phenomena are closely related. For example, an experiment where participants were asked to squeeze on a pair of tongs to represent the tension they perceive in the music demonstrated how easy it is for listeners to translate perceived tension into muscular tension (Nielsen, 1987). In this line of argument, it is conceivable, as theories of embodied cognition propose (Barsalou, 2003; Glenberg, 2010), that even when tension is perceived as located in the music, this

---

[15] See section 2.6 of Chapter 2 for a critical discussion of the evidence for the claim that the musical expectancy and the rhythmic entrainment mechanisms leads to fluctuations of arousal rather than to the induction of full-blown emotions.

percept involves activation of premotor areas of the brain, where bodily states of tension and relaxation are simulated. On most occasions, this simulation only works as preparation for quickly responding to the perceived environmental change, and is experienced as tension in the music. On other occasions, the musical event is so sudden and "urgent", that it provokes an overt response which is observable as a surge in physiological arousal, and experienced subjectively as surprise. This is what the BRECVEMA theory labels the **Brain Stem Reflex** mechanism (Juslin & Västfjäll, 2008).

The close relation between perceived arousal in the music and induced arousal in the listener can also be inferred by observing that many of the musical qualities that are associated with the perception of arousal expressed by music (summarised in Table 3.1, in Chapter 3), coincide with the musical qualities that are associated with variations in levels of autonomic activation in listeners. Studies into physiological effects of music have found that compared to listening to relaxing or sedative music, music with stimulative qualities (e.g. with fast tempo, loud dynamics, rapid changes in dynamics, staccato articulation, etc.) is associated with increases in autonomic responses, such as increases in heart rate, blood pressure, skin conductivity, and respiration rate (Hodges, 2010).

Finally, it is important to stress that the mechanisms that lead to neural and motor resonance to music I described in the first part of this section interact with the mechanisms that produce fluctuations of autonomic and psychological arousal I described in the last paragraphs. This interdependence has been demonstrated in a series of experiments carried out by Leman and colleagues into the effects of music listening on walking (Buhmann, Desmet, Moens, Van Dyck, & Leman, 2016; Leman *et al.*, 2013; Styns, van Noorden, Moelants, & Leman, 2007). In these studies, even when listening to stimuli with the same rate of beats per minute, participants walked faster (i.e. took longer strides) with music than with metronomes, and with music of an arousing quality than with music with a relaxing quality. In other words, the participants in these experiments not only entrained their walking rate to the musical beat, they also adapted the vigour of their movements to the exciting or relaxing qualities of the music.

In summary, in this section I have presented four processes that lead to fluctuations of the arousal dimension of core affect: nonlinear neural resonances to periodic events in the music, activation of simulation mechanisms that produce action plans in the brain, construction and appraisal of perceptual predictions, and psychophysiological adjustments to the tensing or relaxing character of the music. These processes subsume, and at the same time, go beyond the musical expectancy, rhythmic entrainment, and brain stem reflexes mechanisms proposed in the BRECVEMA theory and the Multifactorial Process Model.

5.1.3 Processes and Mechanisms that Lead to Changes in Core Affect II: Valence

The processes and mechanisms I discussed in the previous section focused on how perceiving music leads to changes in arousal. Evidently, it is possible that these dynamics can also lead to changes in valence, but the evidence for this possibility is so far scarce and somewhat contradictory. First, regarding the **musical expectancy mechanism**, as discussed in section 2.6.1 of Chapter 2, most investigations have found that violations of musical expectancies correlate with physiological and experienced changes in arousal, but not of valence (Egermann *et al.*, 2013; Koelsch *et al.*, 2008; Steinbeis *et al.*, 2006). Second, regarding the evidence for the effects of **rhythmic entrainment** on valence, the evidence is again partial, and contradictory: some studies have found significant effects (Labbé & Grandjean, 2014; Witek *et al.*, 2014) while others have found no association (Janata *et al.*, 2012) –See section 2.6.2 of chapter 2, and chapter 6 for a detailed review of this evidence. Finally, regarding the effects of **music on experienced tension**, perhaps the most informative evidence has been provided by Illie and Thompson's experiment (2006) which manipulated and compared the effects of musical loudness, tempo, and pitch height (and their equivalents in vocalizations) and measured the participants affective experience in three dimensions: valence, tense arousal, and energetic arousal. Their results suggest that tension arousal and valence are largely orthogonal dimensions: the musical parameters that are associated with ratings of tension did not present the same patterns of association with ratings of valence.

How does music induce changes in the valence dimension of core affect, then? I submit that rather than depend on mechanisms of sensorimotor processing and appraisals of prediction accuracy (described above), musically-induced valence occurs in part thanks to the activation of quick appraisals of "goodness"/"badness" in the music, and to associative mechanisms derived from implicit learning.

A starting point is again, the premise that perceptual processing involves evaluation of the significance of the present situation for the person's well-being. As explained in section 4.2.1 of chapter 4, this evaluation happens so quickly that it contributes to the construction of the perceptual gestalt itself, and occurs under the threshold of conscious awareness (Lebrecht, Bar, Barrett, & Tarr, 2012). This appraisal, which corresponds to the **intrinsic pleasantness appraisal check** in Scherer's CPM theory (Scherer, 2009a), is also present in music perception. Some of these valence appraisals may have innate origins, such as the preference for consonant over dissonant intervals, which has been observed in infants as young as 4 months of age (Trainor & Heinmiller, 1998; Zentner & Kagan, 1998). Other appraisals may originate in cross-modal associations, such as the above-mentioned association of low-pitched, loud sounds with the presence of large, powerful objects or entities (Granot & Eitan, 2011), or the association of rough timbres with physical states that involve bodily tension or exertion (Scherer, 1986) such as lifting a heavy weight, enduring physical pain, or striking an object.

Although it could be assumed that these quick and primitive appraisals are hardwired to produce the same positive or negative evaluation every time they encounter the same stimuli configuration, there is evidence that they interact with the previous psychological state of the individual, suggesting that they are susceptible of adapting their response according to different contexts. Thus, as mentioned in section 4.2.1 of chapter 4, even amygdala responses are modulated by motivational states (LaBar *et al.*, 2001), and by the type of task performed by the individual (Hariri, Bookheimer, & Mazziotta, 2000). In the case of music, the observation that evaluating dissonant intervals and rough timbres as unpleasant depends on historic and musical contexts is common place. For instance, this type of harmonies and timbres are valued in musical genres such as jazz and rock, correspondingly, and avoided in musical styles such as baroque music. Furthermore, it is easy to envision how assuming a second person, defenceless "subject position" towards the music (Clarke, 2005) can lead a listener to perceive loud, low-pitched musical sounds as specifying the presence of a menacing entity, whereas assuming a first-person subject position, can lead the listener to feel powerful or menacing him or herself.

A second group of mechanisms that produce changes in valence while listening to music arise from processes of implicit learning. First, the phenomenon of **mere exposure**, in which liking towards an object increases after repeated exposure, has been observed for music (Margulis & Simchy-Gross, 2016; Schellenberg, Peretz, & Vieillard, 2008). The two theories proposed to explain this phenomenon rely on an implicit process of learning. In the Two Factor model, repeated exposure increases familiarity with the music, which is therefore interpreted as non-threatening, and more pleasant

(Berlyne, 1971). Similarly, in the Perceptual Fluency model, repeated exposure to the music facilitates its perceptual processing. Since unexpected fluency is inherently pleasant, preference for the music arises (Reber, Schwarz, & Winkielman, 2004).

Two more mechanisms can also be classified in the group of learning-based mechanisms. First, the mechanism called **evaluative conditioning** in the BRECVEMA theory in which simply having listened to a piece of music while undergoing a positively or negatively valenced experience biases our future affective responses to the same or similar music. Second, there are culturally-specific cues to the expression of musical emotions that are learned in the process of familiarisation with the music from our social environment, known as **enculturation**. For example, the association between major mode and the expression of positive affective states, and minor mode and the expression of negative ones, emerged gradually along the last seven centuries in Western classical music (Parncutt, 2014), and becomes internalised by children by age 8 (Gregory *et al.*, 1996). Research has also found how listeners from different cultures are more sensitive to musical cues to emotion that are specific to their musical traditions, such as the association of the melodic modes with different moods in classical Hindustani music (Laukka *et al.*, 2013). (See sections 33.2 and 3.3.3 of Chapter 3 for a critical review of evidence from cross-cultural and developmental studies).

In summary, in this section I have described several mechanisms that become quickly activated in music perception, and that lead to changes in the valence dimension of core affect: quick appraisals of the intrinsic goodness of the stimulus, and mechanisms that develop from learning processes, such as mere exposure, evaluative conditioning and enculturation. To conclude, I submit that unlike the close relationship between musical structure and changes in arousal explained in the previous section, fluctuations of valence are harder to predict on the basis of the musical structure only. A person's valence state while listening to music emerges from the interaction of these "goodness/badness" appraisals and associations with many other factors: the person's circadian rhythms, bodily sensations, present goals, aesthetic preferences, narratives presented while listening to the music, the significance of the event in which the listening takes place, etc. All of these interactions can easily overrule the effects of the primitive appraisals and associations, amplifying them or even contradicting them.

5.1.4 Musically-induced Experiences of Motion

There is an additional source for music's impact on our imagined, simulated or overt bodily states: the way musical sounds can specify or evoke experiences of motion. These experiences range from perceiving the movements of a virtual object or persona in the music (Eitan & Granot, 2006; Karl & Robinson, 1995), to first person experiences, in which we feel as if moving in a virtual environment, or we feel objects moving around us (Clarke, 2005). From my point of view, these musically-induced experiences of virtual motion can only have an impact on our core affect to the extent that they: a) are perceived from a first person perspective, producing the type of motor action plans (i.e. embodied simulations) that I discussed in section 5.1.2 above; or b) are evaluated as specifying pleasant or unpleasant object or agents (either from a first or second person perspective), and therefore activate the appraisals of pleasantness I discussed in section 5.1.3

5.2 Affective dimensions of musically-induced core affect

In the first three sections of this chapter I have explained how the interaction of perceptual processes and material properties of music give rise to fluctuations of core affect, defined as fluctuations of valence and arousal. Several authors, by contrast, have proposed further distinguishing arousal as constituted by two dimensions: energetic arousal, and tense arousal. They argue that the two types of arousal emerge from different physiological processes (Thayer, 1989), and that people can easily describe their experiences separating the wakefulness/tiredness component of their feelings, from the tension/relaxation component (Schimmack & Grob, 2000). Yet other authors, drawing upon a linguistic perspective (Fontaine *et al.*, 2007), have proposed that affective responses are better described in four dimensions: valence, arousal, power or control, and novelty. I examine these three possibilities in this section.

In the context of musically-induced emotions, it can be useful to conceptualise arousal as comprised of two dimensions, because we can intuitively conceive relations between variations in tense-arousal and perceptions of harmonic tension; and between variations in energetic-arousal and variations of tempo and loudness, for example. Additionally, discriminating energetic arousal from tense arousal can help differentiate musically-induced emotions with similar levels of valence and energy such as sadness and anxiety, which imply different levels of tension (Illie & Thompson, 2006).

Despite this potential usefulness of the three-dimensional approach, the majority of music and emotion studies that have implemented a dimensional approach, have adopted the traditional dimensions of valence vs. arousal (Eerola & Vuoskoski, 2013); and only handful of studies have distinguished the two types of arousal (Eerola & Vuoskoski, 2011; Illie & Thompson, 2006; van der Zwaag, Westerink, & van den Broek, 2011). These studies have reported high levels of agreement in the participants' ratings of tense and energetic arousal, suggesting that listeners can discriminate the two dimensions; but at the same time, they have found high levels of correlation between these two dimensions, suggesting that they can parsimoniously be collapsed into a single one. To my knowledge, the power or control dimension has only been explored in three studies, and they do not completely agree in the way they defined this construct. In Huron and colleagues' experiment (2006), participants rated submissiveness and dominance expressed by music using synonyms like "politeness", "timidity", and "aggressivity," "threateningness," and "heaviness", correspondingly. In Schubert's (2007) study, participants rated felt and expressed "dominance" using a seven point scale from submissive to dominant. And in Luck *et al.* (2007), participants were asked to rate perceived "strength" using a slide that range from weak to strong. In consequence, more research is needed to establish the extent to which the power/control dimension is relevant in emotional experiences with music. To my knowledge, the novelty dimension proposed by Fontaine and colleagues (2007) has not been explicitly included in any music psychology studies. However, it can be assumed that studies on musical expectancy have implicitly addressed this dimension.

In contrast to the arguments for the advantages of using a three-dimensional model, there are also arguments for adopting the view that musically-induced core affect arousal and valence constitute the most prominent dimensions in musically-induced core affect. First, in a recent fMRI experiment that aimed to establish the relationship between ratings in the factors of the GEMS and brain activity, Trost and colleagues (2012) found that the patterns of brain activation could be mapped onto four groups, corresponding to the four quadrants that constitute the arousal and valence dimensional space. Second, Eerola & Vuoskoski (2011) found that reducing the three dimensions into two did not significantly decrease the amount of explained variance.

And third, it is more parsimonious to use two dimensions (than three, four or more) to account for the variability of musically-induced affective responses.

In conclusion, the evidence so far suggests that musically-induced fluctuations of core affect can, at the very least, be described as variations in valence and arousal. The possibility that listeners experience more dimensions such as variations in power, energy and tension is still an open empirical question, which I address in the experiments reported in chapters 6, 7 and 8. Nevertheless, it is possible to speculate that the possibility of experiencing distinctions in these further dimensions depends on the material characteristics of the music, and the characteristics of the listening situation. For example, watching a contingent of soldiers march to military music can make the power dimension more prominent, whereas listening to electronic dance music while jogging can make the energy dimension more relevant, but not necessarily the dimensions of tension, and power. Future studies attempting to establish the best way to describe the dimensions that underlie affective responses to music need to establish the musically-structural and contextual conditions under which these dimensions become more salient and differentiated. Additionally, it is necessary to establish if the dimensions are to be defined on the basis of physiological systems (i.e. the architecture of the nervous system), or on the basis of the terms listeners use to describe their subjective feelings.

5.3 How do musically-induced changes in core affect become discrete emotional episodes?

I have discussed so far the processes and mechanisms that lead to fluctuations in core-affect when we listen to music. Based on the evidence I reviewed in section 1.3 of Chapter 1, I submit that on most occasions, our affective responses to music do not go beyond this basic level. That is, many times musically-induced affect has low intensity, and is experienced only at the level of primary consciousness. These affective experiences consist in fleeting and mostly un-memorable reactions (i.e. preferences, proto-affect or automatic affect according to the classification proposed in Chapter 1), or in more lasting, but barely noticeable changes in our diffuse, underlying affective tone (i.e. moods). In this section I explain the processes and mechanisms that make our musically-induced affective responses go beyond this basic level, to become intense, full-blown, discrete emotional episodes.

As explained in section 4.2.2 of the previous chapter, according to Barrett (2006b), the transformation of core affect into a discrete emotional episode occurs when core affect is categorised by a **conceptual act**, which consists in reinstating information from experiences of the same type in the past (i.e. activating processes of simulation), and adapting it to the demands of the present situation. Hence, for the Conceptual Act Theory, the processes involved in this transformation are basically associative (Moors, 2009). In contrast, for Clore & Ortony (2013), and for Cunningham *et al.* (2013) the transformation of diffuse affective reactions in to discrete emotions also involves the progressive activation of rule-based mechanisms of appraisal. In my view, both type of mechanisms are involved in the transformation of musically-induced core affect into discrete emotions, as I go on to explain below.

The situated character of emotions proposed by constructionist approaches means that the **social significance of the musical event** as a whole is the most important source of activation of the mechanisms that produce the conceptual act (henceforth called "conceptual mechanisms"). It can be argued that in every situation where we listen to music (even in solitary contexts), our experience is fundamentally shaped by culturally-shared knowledge about the meaning of the situation. This knowledge present us with a set of pre-given expectations and implicit understandings about the role of the music in the event, about what the music is about, about the right listening attitude we should have, about the behaviour that is expected from us and from other participants in the event, and so on (Becker, 2010). These conventions in turn predispose us to take particular bodily and psychological attitudes towards the music and the rest of the elements in the situation (for instance, it can make it more likely that we dance and sing along instead of listening quietly, that we pay attention the lyrics or not, that we engage in nostalgic reminiscing or that we focus on the present situation, that we value the musicians' virtuosity or not, etc.). In consequence, the conceptual mechanisms activated by the meaning of the social situation do not transform core-affect *a posteriori*, that is, once the changes in arousal and valence have been completely formed (as proposed by Russell, 2003). On the contrary, on a psychological level, the conceptual mechanisms can be regarded as constituting a bodily and psychological context that shapes the fluctuations of core-affect from the very beginning, even before the music has started to play[16].

---

[16] A clear example of the importance that the social significance of the musical event has been provided by Bonini Baraldi (2009), who adopting an ethnographic methodology, found that gipsy

On some occasions, the combination of the demands of the situation and the bodily and psychological context of the listener produce the conceptual act that transforms core affect into discrete emotional episodes. In general terms, the effect of these conceptual mechanisms is to make our affective reaction to music more personally relevant and specific. If the changes in core affect I described in the previous sections can be regarded as a general representation of the importance and value of the present situation (Clore & Schnall, 2008), then the mechanisms that transform core affect into discrete emotions make that representation more specifically directed towards an object. It is important to note that although the activation of conceptual mechanisms is usually quick and implicit, their effects can be consciously experienced as contextual clues, narratives, explanations, and emotional labels about the cause of our emotional reaction, and about its relation to our personal history, our present goals, and the social significance of the present situation.

5.3.1 Conceptual Mechanisms I: Associations Activated by Musical Sounds

Evidently, the most important associative mechanism that can facilitate the induction of an intense and personal emotional reaction to music is the activation of **episodic memories**. This mechanism, included both in the BRECVEMA theory, and in the Multifactorial Process Model, consists in the restoration of the same emotional reactions that we originally experienced in past experiences with a piece of music (Juslin & Västfjäll, 2008; Scherer & Coutinho, 2013).

There are abundant anecdotal recounts of this link between personal memories and musically-induced emotions (e.g. Hornby, 2003), but surprisingly little empirical research about it. An exception is the study carried out by Janata and colleagues (2007), which aimed to characterise music-evoked autobiographical memories. These researchers found that the songs that listeners rated as more autobiographically salient tended to be associated with emotional episodes, and with more intense emotional responses during the experiment. In a subsequent study specifically focused on musically-induced nostalgia, Frederick Barrett and collaborators discovered that nostalgia can be induced by music listening even when the evoked memories correspond to a general time in the

---

communities in Romania play the same musical pieces in weddings and funerals, but the pieces facilitate the expression and arousing of very different emotions in each context.

person's past (e.g. listening to a song during high-school) and not to particular events (e.g. listening to the song at a particular party) (F. S. Barrett *et al.*, 2010). However, as expected, these researchers also found a positive correlation between the participants' ratings of the specificity of the evoked memories, and their ratings of intensity of induced nostalgia while listening to the music.

The observation that memory associations with music do not need to be specific to evoke emotional responses suggests that **semantic knowledge activated by music** can also have emotional consequences. It can be argued that since music is a culturally constructed artefact, then musically-activated memories are never really completely idiosyncratic. Music makes part of many culturally significant events, and is used in many contexts to communicate meaningful connotations. In consequence, we tend to experience music as "loaded" with symbolic meanings, even when we listen to it in solitary settings. To the extent that these symbolic meanings have emotional connotations, their activation can contribute to the induction of emotional responses to music.

Several lines of research have demonstrated how easy it is for listeners to access this culturally-constructed semantic knowledge when listening to music. First, in a study that aimed to explore the ecological character of music perception, Dibben (2001) asked participants to listen to sound clips of everyday and musical sounds, and asked them to simply describe what they heard. She found that many of their descriptions corresponded to the objects and materials that produced the sounds, but also to cultural information about the music, such as its genre (e.g. "classical music", "horror movie soundtrack"), the musical function of the fragment (e.g. "musical ending"), the social context in which that type of music is listened to (e.g. "formal dinner dance", "religious festival"), and stereotypical emotional associations (e.g. "depressing sad, piano music"). Second, a study that compared the extra-musical concepts associated with popular music genres in listeners from two cultures (Germany and the USA) Kristen and Shevy (2012) found high levels of agreement between listeners and across cultures, especially for internationally recognised genres. However, at the same time, they found more marked differences between the two cultures when the listeners described genres that they were more familiar with (e.g. German folksy music, and Hip Hop, correspondingly). Third, the use of music in advertisement and in commercial establishments also demonstrates how implicit semantic concepts activated by music have effects on consumers' attitudes towards the products, and the store (North &

Hargreaves, 1998; North, Hargreaves, & McKendrick, 1997). And fourth, a series of experiments carried out by Koelsch and colleagues showed how listening to short musical excerpts conveys semantic information (Koelsch *et al.*, 2004; Painter & Koelsch, 2011; Steinbeis & Koelsch, 2008). In all of these experiments, the researchers presented participants with pairs of musical and verbal stimuli, and found increased neural responses when the semantic information elicited by the verbal stimulus was incongruous with the information elicited by music. Importantly, in the second experiment (Steinbeis & Koelsch, 2008) the researchers used target words with affective connotations as primes (e.g. “love”, “hate”), suggesting that music can quickly convey semantic information of an affective character.

How does the activation of semantic knowledge contribute to the induction of emotions? The answer lies in the embodied character of conceptual knowledge. Based on Barsalou’s Perceptual Symbols Systems theory (Barsalou, 2003), Niedenthal and Barrett have proposed that even abstract concepts, such as “love”, “joy”, “divinity”, “patriotism”, etc., are represented in the brain as embodied simulations of bodily states, sensations, introspective states, and action tendencies (Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011; Winkielman, Niedenthal, Wielgosz, Eelen, & Kavanagh, 2015). And since according to Barrett (2006b), the conceptual act that transforms core affect into emotions consists in partially re-activating (i.e. simulating) sensorimotor and introspective states from similar past emotional experiences, it is conceivable that musically-evoked semantic concepts contribute to the induction of emotions by activating these embodied simulations. Thus, the cultural meanings associated with a musical piece or musical genre can influence our emotional responses to music, because those meanings predispose us to experience the “right” type of emotions associated with that type of music. For instance, a piece of classical music can activate the semantic notion of “solemnity”, and facilitate the partial re-activation of an experience of attending a classical concert where we felt admiration and awe; whereas a piece of pop music can activate the notion of “summer party”, and facilitate the partial re-activation of the experience of being in a BBQ where we felt joy and relaxation. –This hypothesis about the effects of semantic knowledge on musical emotions is tested in the experiments reported in chapters seven and eight.

5.3.2 Conceptual Mechanisms II: Associations Activated by "Extra-Musical" Factors

The second group of associative mechanisms corresponds to semantic information that is not provided by personal or cultural connotations evoked by musical sounds, but by the immediate context in which music listening takes place. Cook has noted how our experiences of music are almost always embedded in multimedia contexts (1998): we do not only listen to sounds, we also see the performers' gestures, the behaviour of other people listening to the music, or we see CD sleeves, visual narratives in a film or in music videos, etc. Just like the semantic connotations described in the previous section, these other sources of musical meaning influence our emotional reactions to music.

Recent research has provided evidence that the **visual information provided by the performers' gestures** has effects on the observers' perception of music. In a series of experiments, Thompson and colleagues found that the performers' gestures biased the perception of dissonance, interval size, and valence expressed by music (Livingstone, Thompson, & Russo, 2009; Livingstone, Thompson, Wanderley, & Palmer, 2015; Thompson, Graham, & Russo, 2005; Thompson, Russo, & Quinto, 2008). It is therefore probable that these gestures can also have effects on the elicitation of emotions by music, too, for example by facilitating emotional contagion and the induction of empathic responses to the emotions expressed by the performer[17]. A study carried out by Miu & Balteş (2012) supports this prediction. In this experiment, participants observed audiovisual performances of Cecilia Bartoli, an opera singer characterised by her histrionism. The researchers found that those participants who were instructed to adopt an empathic attitude towards the singer experienced more intense induced emotions, and had stronger physiological responses than those participants who were instructed to adopt a detached attitude.

Despite the fact that most music that people listen to in daily life contains **lyrics**, few studies have investigated the influence of these verbal narratives on emotions expressed and induced by music; most research has been interested in their effects on social attitudes, instead (Anderson, Carnagey, & Eubanks, 2003; Fischer & Greitemeyer, 2006; Guéguen, Jacob, & Lamy, 2010). To my knowledge, only three studies have attempted to disentangle the contribution of lyrics and music on emotional experiences. The first study, carried out by Thompson and Russo (2004) investigated the effects of

---

[17] I discuss the evidence for emotional contagion with other people's expression in Chapter 7.

music on the interpretation of lyrics. In several experiments, they asked participants to either listen to music with lyrics, or to read the lyrics alone. They found that pairing lyrics with music was associated with higher ratings of expressed emotion in the stimuli, and that the more participants were familiarised with the music, the more music enhanced the perception of meaningfulness of the lyrics. Ali and Peynircioğlu's study (2006), in contrast, focused on perceived emotions in the songs. In one of their experiments these researchers presented participants the same melodies with or without lyrics. They found (unlike Thompson and Russo, 2004), that the simultaneous presentation was associated with higher ratings of perceived emotion only in songs that expressed negative emotions (sadness and anger), but not in songs that expressed positive ones (happiness and calm). In three other experiments, they found that when the music expressed one emotion and the lyrics another, the participants' perception of the message communicated by the song was always driven by the musical component. Finally, in the only experiment specifically aimed at testing the effects of lyrics and music on induced affect, Mori and Iwanaga (2014) asked participants to listen to two happy-sounding songs that contained sad lyrics. Crucially, both pieces were sung in languages that the participants could not understand. In one condition, participants listened to the songs without having any information about the meaning of the lyrics; in a second condition, they read the translation of the lyrics only; and in a third condition, they listened to the music while reading the translation. The authors reported three main findings. First, in general, the participants experienced positive feelings while listening to the songs independently of their awareness of the lyrics' meanings. Second, reading the lyrics alone was associated with higher ratings of induced negative feelings. And third, listening to the song while reading the translation of the lyrics did not lead the participants to experience more induced negative feelings than listening to the song while oblivious of the lyrics' meaning.

Taken together, the results of these experiments suggests that when music contains lyrics, the emotional meanings afforded by the musical materials take precedence in listeners' perception of emotions expressed by the songs, and in the emotions that they arouse. Consequently, it is possible to hypothesise that lyrics can only produce nuances within the boundaries of core affect specified by the music materials. This is an interesting possibility, because it is somewhat contradictory to the claims of the Conceptual Act Theory about the role of language in emotional processes. According to this theory, language dynamically constrains and configures the process of emotion perception and induction from the start (Barrett, Lindquist, & Gendron, 2007; Lindquist, 2009); that is, the role of language is not limited to providing a label to an already formed emotional reaction (as claimed by Russell, 2003, p. 165). These experiments, in contrast, suggest that the effects of music on participants' core-affect had more weight on the participants' emotional percepts and affective reactions than the verbal content present in the lyrics. Future research is needed to test this hypothesis, carefully controlling and testing the influence of each factor (music and lyrics).

A closely related line of research has investigated the effects of **previously presented information about the music** on listeners' affective experiences. Two recent investigations have studied this phenomenon. First, interested in the effects of programme notes on listeners' *enjoyment* of classical music, Margulis (2010; 2015) carried out two experiments in which she manipulated the content of the programme notes read by participants before a concert. The most significant finding across both experiments is that exposing participants to information about the music (compared to giving them irrelevant information about the venue, and to not giving them any information at all) decreased the participants' enjoyment of the music. A second study was carried out by Vuoskoski and Eerola (2013), who were interested in the effects of previously presented information on the *induction* of emotional responses in listeners. In this experiment, three groups of participants listened to the same sad-sounding piece of music. Additionally, before listening to the music, the first group read a narrative describing a sad narrative, the second group read a narrative describing a neutral narrative, and the third group listened to the music without reading anything before. The results of the experiment suggest that compared to the other groups, participants who read the sad narrative experienced more induced sadness, and evoked more sad imagery while listening to the music. The authors interpreted these results as stemming from the activation of the visual imagery mechanism proposed by the BRECVEMA theory (Juslin & Västfjäll, 2008).

The BRECVEMA theory defines this **visual imagery mechanism** as a process whereby a listener responds emotionally to the visual images that he or she conjures while listening to the music (Juslin & Västfjäll, 2008, p. 566). In my view, there are two reasons to be sceptical about the power of this phenomenon. First, it is possible that the conjured images are just an epiphenomenon of music listening when we do not have any simultaneous visual stimulation that draws our attention (Thompson & Coltheart, 2008). Second, research on cognition has found that visual imagery is not necessary for reasoning, nor for language comprehension (Pecher, van Dantzig, & Schifferstein, 2009; Rommers, Meyer, & Huettig, 2013), suggesting that the evoked images might be a secondary process to non-conscious processes of activation of semantic knowledge. Despite these objections, it is also conceivable that on occasions, the evoked visual images configure narrative scenarios, and in this way, generate further simulations of past emotional experiences, which facilitate the induction of emotions[18].

An ideal starting place to investigate how **imagined or observed visual narratives experienced along music** influence people's emotional responses would be to study people's experiences with film music and music videos. Unfortunately, even though the last years have seen progress in understanding of the processes of perceptual integration of musical and visual narratives (Boltz, Ebendorf, & Field, 2009; Cohen, 2001; Tan, Spackman, Bezdek, & Paterson, 2007; Thompson *et al.*, 2005), to my knowledge, there has been very little research on how these two sources of meaning interact to induce emotional responses in the spectators. Thus, researchers have found that musical soundtracks bias observers' perception of the visual narrative, including their inferences about the emotions felt by the characters in the film (Tan *et al.*, 2007). Most of this research has confirmed the well-established finding that when visual and auditory information are paired the visual information takes primacy (Bolivar, Cohen, & Fentress, 1994; Thompson, Russo, & Sinclair, 1994), but recent investigations have also found evidence that this effect is moderated by the degree of temporal and semantic congruence between the two sources of information. For instance, Boltz (2001) found that when the information provided by the visual component is ambiguous, the musical component disambiguates the intended message. Conversely, in a posterior study, Boltz and colleagues (2009) found that when the information provided by the music is emotionally ambiguous, the visual component disambiguates the message in a mood-congruent manner. In contrast, Pavlović and Marković (2011) found a more complicated pattern of results. These researchers made emotionally incongruent pairs of film clips and music, and found that some of the pairings led to a negative effect of music (e.g. joyful music made a sad scene appear less sad), some led to positive effects (e.g. fearful music made an angry scene appear more angry), and some pairings did not produce any modulation (e.g. sad music did not make a joyful scene any less or more joyful).

---

[18] Chapter 8 presents an experiment testing these possibilities by expanding Vuoskoski and Eerola's (2013) findings with pieces of music that express emotions other than sadness.

Regarding the effects of audiovisual musical stimuli on the induction of affective responses, there has been even less research[19]. To my knowledge, only four studies have directly researched this phenomenon. The first two studies, carried out by Geringer and colleagues (1996, 1997) compared participants' experiences with pieces of classical music presented as audio alone, or accompanied by videos. These researchers found that two out of the four audiovisual stimuli were associated with higher scores of liking and emotional involvement with the pieces. Regrettably, the authors do not provide details about the mean scores for each of these dimensions, and it is not clear if the participants were instructed to rate induced or perceived emotions. The second group of studies, conducted by Baumgartner and collaborators found a similar additive effect of music and images (Baumgartner, Esslen, & Jäncke, 2006; Baumgartner, Lutz, Schmidt, & Jäncke, 2006). They presented participants with music only, images from the IAPS, or music combined with the images, and found that the music was associated with the lowest signs of emotional involvement, and that the combined stimuli were associated with the highest.

In summary, the hypothesis that extra-musical information plays an important role in listeners' affective responses to music still awaits to be thoroughly tested. It is likely that the induction of an emotional response will depend on a combination of factors such as the extent to which the music and the verbal or visual elements are congruent and facilitate the creation of a unified percept, how clear and absorbing the visual and verbal narratives are, and the extent to which the observer actively attends either the music or these other elements of the stimulus. It is urgent that researchers on music and emotion pay more attention to these phenomena, particularly considering that the vast majority of music that people listen to contains lyrics, and that in contemporary societies, people's experiences with music increasingly involve the presence of visual and verbal elements such as music videos, photos, webpages, etc. There is evidence that watching music videos on services such as youtube.com has become one the predominant ways of accessing music during the last few years in the U.S.A (Nielsen, 2016), a trend that is probably paralleled in other countries with widespread internet access.

---

[19] It is telling that there is no mention of studies of this type in the chapters dedicated to film music and emotion in any of the two volumes of the "Music and Emotion" book (Juslin & Sloboda, 2001, 2010a).

5.3.3 Conceptual Mechanisms III: Rule-Based Appraisals

In the last two sections I have described several mechanisms that enrich the fluctuations in core-affect by relating them to meaningful associations and narratives. However, I submit that most of the time, the activation of these associative mechanisms does not lead to the induction of emotions, because as explained before, the transformation of core-affect into discrete emotions tends to occur when there is something in the situation, and/or in the music that is evaluated as *personally relevant*. In this sense, while all of these associative mechanisms make the musical event more meaningful, and thus increases the probability of having an emotional response, only the episodic memories mechanism can lead to the induction of emotions on its own, because it directly involves the simulation of situations that were personally significant in the past. Indeed, if the activation of semantic knowledge, or the presence of visual or verbal narratives could lead to the transformation of core affect into a discrete emotional episode on their own, then we would experience a full-blown emotional episode almost every time we listen to music! Since this is clearly not the case, I propose that on most occasions, the transformation of musically-induced core-affect into discrete emotions requires not only the contribution of associative mechanisms, but also the activation of appraisal mechanisms, which provide the needed element of personal relevancy to the situation.

It is important to note that in this section I do not address appraisal mechanisms based on the activation of primitive, sensorimotor connections, and evaluations of perceptual predictions, because I already described them in section 5.1 above. Here I describe appraisal mechanisms that depend on the activation of propositional knowledge, and therefore, tend to be less automatic, slower, and at times, conscious. In the summary I present below, I integrate elements from Scherer's CPM (Scherer, 2009a) and from Clore and Ortony's theory (2000, 2013) about the types of appraisals involved in the elicitation of emotions.

The first type of appraisal evaluates the extent to which the musical event is **desirable or undesirable for our goals** in the present situation. Since in contemporary Western societies, listening attentively to music is rarely the main activity when we are exposed to it (Juslin *et al.*, 2008; Sloboda *et al.*, 2001), then most of the times these appraisals consist in evaluating the extent to which the music facilitates or obstructs the other task we are doing at that moment. On other occasions, we listen to music with the explicit objective of regulating our affective and motivational states, therefore, the appraisal becomes a meta-evaluation of the degree to which the music helps us reach the desired state.

The second type of appraisal has to do with the **degree of control** that we have over the present situation (equivalent to Scherer's *coping potential checks*, 2009). In musical contexts, Sloboda *et al.* (2001) and Krause and colleagues (2015) found that people are quite tolerant to the presence of music that they have not selected themselves, but they also found that the more people can handle the choice, the more likely they are to experience positive emotions. Of course, it is easy to imagine the opposite case. Even music that we usually like to listen to can be experienced negatively if it disrupts our present goals, and we cannot do anything to make it stop.

The third type of appraisal consists of evaluations of the **aesthetic value of the music, and/or the musicians**' ability, creativity, etc. (Juslin, 2013a; Scherer & Coutinho, 2013). In this case, we make use of personal and socially-shared aesthetic criteria to approve or disapprove the music's beauty, complexity, challenge, and the musicians' gestures, technique, flair, deviance from stylistic standards, etc. While the two types of appraisals described above increase the probability of experiencing a wide range of positive or negative emotions, the appraisals of aesthetic value tend to produce emotions such as admiration, awe, or on the contrary, disdain, contempt, or boredom.

5.4 The crucial role of attention in shaping affective responses to music

In this section I add a final intervening element in the process of induction musical emotions: attentional deployment. Although attention is influenced by all the mechanisms described so far, the level and type of attention that a person dedicates to a musical event is not solely determined by those processes, because attention can be modified by volition (for example, we can decide to not pay attention to our physical sensation of tension, to not engage in nostalgic thoughts, or to ignore the presence of a beloved piece of music on the background which can distract us from the task we have at hand).

My proposal is that the different levels and types of attention we devote to a musical event can make the difference between having a world-focused affective experience, an experience of perceiving emotions in the music, or an experience of undergoing an emotional reaction ourselves. Drawing from Petti and Cacioppo's Elaboration Likelihood Model (1986), Barsalou and colleagues' theory about levels of processing (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005), from Dibben's findings about people's modes of hearing music (2001), and from Lambie and Marcel's theory of the role of consciousness on emotion (2002)[20], I submit that listening to music can be described as occurring on three different levels of attention, according to the degree of elaboration of meaningful relationships between musical sounds and the rest of the situation:

A shallow-level. In this mode of attention we pay little attention to the music, or listen to it without engaging in elaborating its (personal and cultural) meaning. The music is so unrelated to our present goals and/or has so little personal resonance, that it is only experienced as a general sonic background. When we are engaged in this mode of attending, it is less likely we have any emotional reaction to the music, and when we do, our affective reaction tends to be diffuse, short-lived, of little intensity, and world-focused, rather than self-focused. Remember from chapter one, that in world-focused affective reactions, our attention is placed on the situation, and therefore, we perceive objects or events as having affective qualities (e.g. inviting or repulsive), rather than reflect on how the object changed our own affective state (Lambie & Marcel, 2002).

A cognitively engaged, but emotionally detached-level. In this mode of attention we pay more attention to the music, but it does not evoke meaningful associations with personal events, we do not have the goal of using it to regulate our mood, or it is not relevant for our present goals. This could happen for example when our objective is to listen to music only focusing on "cold" structural aspects of it which do not have a personal resonance, like the changes in timbre or harmony.[21] In this case we tend to experience emotions as if they were *in* the music, rather than in ourselves. Even though this mode of attention can correlate with changes in patterns of physiological activity, we do not consciously experience a shift in our affective state.

---

[20] This classification is also close to the way Clarke and Dibben have applied the concept of subject-position to music perception (Clarke, 1999, 2005; Dibben, 2006).

[21] Of course, it is plausible that even this type of analytical listening may have personal resonance for some listeners if for example, the person engages in this type of "structural-analysis"-kind of listening, while at the same time feeling *admiration* (or on the contrary, *contempt*) for the skills of the musicians.

A deep, emotionally involved level. In this mode of attention we actively engage in constructing meanings out of the listening experience, because the music is relevant to our goals, and/or the associative mechanisms have established enough significant connections with personal events from our life. This could happen even in those cases in which music is not the main focus of attention, but is still an important part of the present situation, such as when we experience music embedded in multimedia such as T.V adverts and movie soundtracks. When we engage in this type of attending, it is more likely that we experience a discrete musical emotion, and that this reaction is moderately long, and intense.

On some occasions, the emotional episode can be world-focused, such as when we experience an intense emotional reaction of admiration for a performer on stage, or when we are deeply engaged in watching a film, and the combination of the visual narrative and the musical soundtrack makes us empathise with the characters on the screen. On other occasions, the experience can be self-focused, and therefore we realize that we are undergoing an emotional episode. In this last case, it is more likely that we engage in processes of emotion regulation (Gross & Barrett, 2011).

5.5 Emergence of full-blown, discrete emotions

In the second half of this chapter I have explained how the changes in core affect induced by music are shaped into discrete emotions thanks to associative mechanisms and rule-based appraisals. Additionally, I argued that different modes of attending to music relate to different affective responses to music. In line with the claims of the constructionist approach I described in the previous chapter, all of these mechanisms can be considered psychological and situational contexts, which shape and constrain the fluctuations of core affect into diffuse affective reactions or into discrete emotional episodes.

There are probably other mechanisms that influence this process, which work as more “distal” contexts. These factors correspond to individual differences in cognitive and affective styles, whose activation and effect depend on the demands of the present situation. I include here differences in musical abilities (e.g. there is evidence that people with more musical training are more sensitive to dissonance, Dellacherie, Roy, Hugueville, Peretz, & Samson, 2011); styles of listening and preferences (e.g. some people prefer to pay attention to the lyrics, others pay little attention to them), personality dispositions (e.g. people high in the neuroticism trait tend to experience more music-induce nostalgia, F. S. Barrett *et al.*, 2010); and people with high openness and empathy traits tend to enjoy and respond with more emotional intensity to sad music (Vuoskoski, Thompson, McIlwain, & Eerola, 2012).

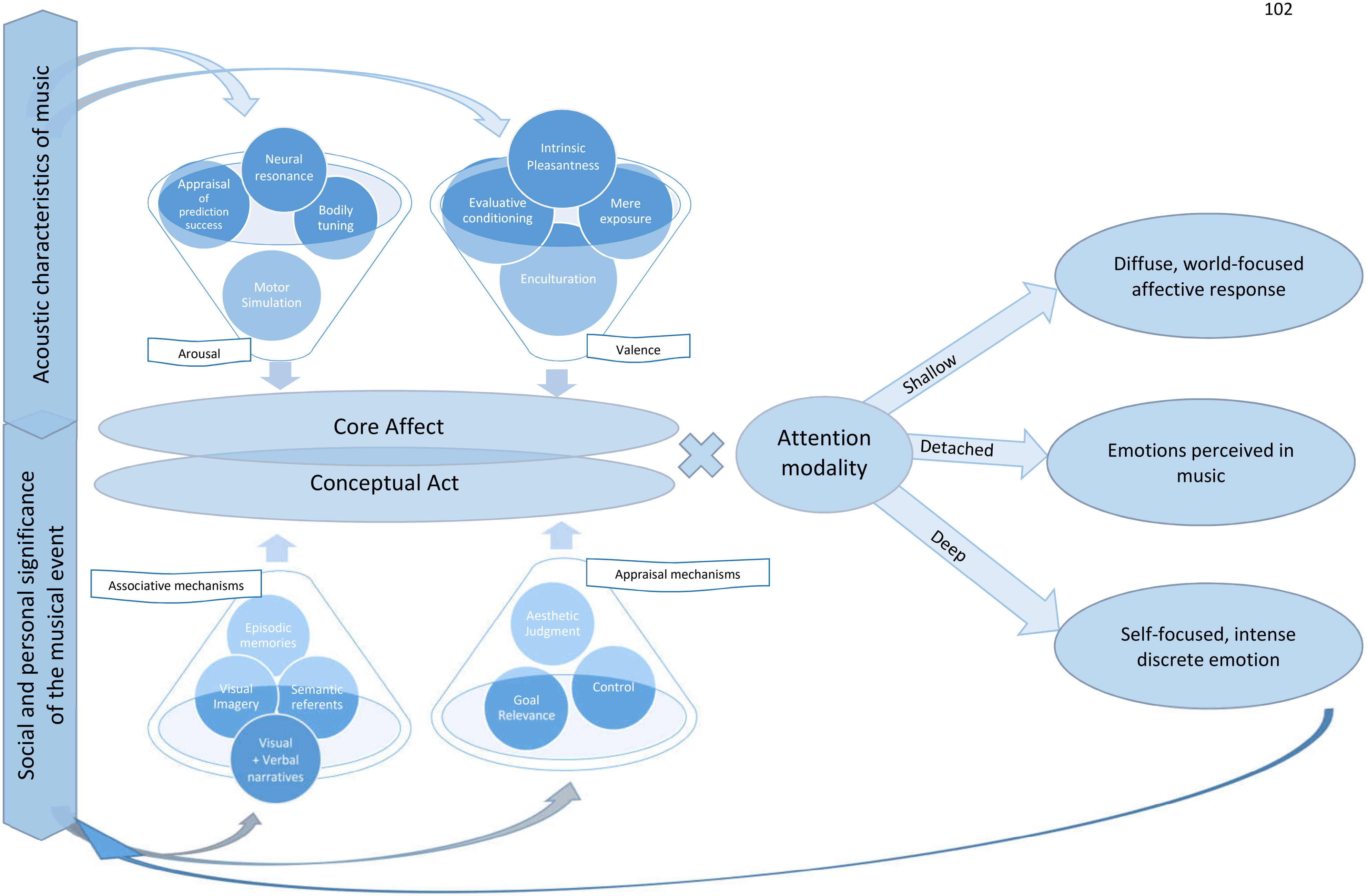
As is probably already evident from the large number of processes and mechanisms I have discussed in this chapter, discrete emotional episodes emerge from complex interactions of many factors, which are only sporadically present in the right combination, producing the “perfect emotional cocktail”. In fact, although in the first chapter I presented a set of *definitional* criteria to establish the boundaries between diffuse affective responses and emotions proper, the question of how to *empirically* establish that threshold is still a matter of debate and investigation among affective scientists. For instance, Scherer and collaborators (Meuleman & Scherer, 2013; Sander, Grandjean, & Scherer, 2005; Scherer, 2009a) have started to explore the validity of nonlinear dynamic systems analysis to determine the degree of connectivity or coherence between the components of emotional responses. Nevertheless, this complexity should not be taken as meaning that this phenomenon cannot be studied empirically. On the contrary, I finish this chapter by presenting ten hypotheses derived from the theoretical framework I laid out.

5.6 Graphic model of the Constructionist Theory of Musically-Induced Emotions

The diagram on page 102 summarises the process of elicitation of emotions by music according to the constructionist theory I proposed:

- The musical event is represented in the two boxes on the leftmost side of the figure. This event can be thought of as constituted by two dimensions: the acoustic characteristics of the music, and its social and personal significance. Although these two dimensions are closely related, they activate two different types of mechanisms: automatic perceptual mechanisms that produce variations of ***core affect*** (represented on the top side of the figure), and ***conceptual mechanisms***, that situate the musical event in the landscape of the cultural meaning of the music, the listener’s personal history, current goals, and aesthetic values.

- For the sake of clarity, the **core affect mechanisms** are grouped into two categories (represented by the two top funnels in the diagram): mechanisms that have effects on *arousal*, and mechanisms that have effect on *valence*. These mechanisms are activated automatically when we listen to music, and their interaction produces fluctuations of core affect.
- The **conceptual mechanisms,** (represented by the two bottom funnels in the diagram) are also grouped into two large categories: *associative mechanisms*, that activate emotionally-relevant information from past experiences, and *appraisal mechanisms*, that evaluate the significance of the music according to the listener's current goals and aesthetic values. The activation of these mechanisms and their interaction produce a *conceptual act*, which constantly shapes the variations in core affect producing different affective states.
- The multiplication sign ("x") in the centre of the diagram represents the notion that the emergent affective states interact with the type of attention that the listener devotes to the musical event. This interaction produces a variety of non-emotional and emotional responses to music, which can be grouped into three large categories (represented by the three ellipses on the rightmost side of the diagram): experiencing diffuse, world-focused affective responses to the music; experiencing emotions as expressed by the music (rather than aroused in the listener); and experiencing intense, discrete, self-focused emotions.
- Finally, the arrow in the bottom represents the notion that this process is recursive: the affective response of the listener modulates the personal significance of the musical event, producing further cycles of activation of the conceptual mechanisms, and therefore, further interactions between conceptualisation and core-affect.


Acoustic characteristics of music
Social and personal significance of the musical event
Neural resonance
Appraisal of prediction success
Bodily tuning
Motor Simulation
Arousal
Intrinsic Pleasantness
Evaluative conditioning
Mere exposure
Enculturation
Valence
Core Affect
Conceptual Act
Attention modality
Shallow
Detached
Deep
Diffuse, world-focused affective response
Emotions perceived in music
Self-focused, intense discrete emotion
Associative mechanisms
Episodic memories
Visual Imagery
Semantic referents
Visual + Verbal narratives
Appraisal mechanisms
Aesthetic Judgment
Goal Relevance
Control

5.6 Empirical predictions

1. Music perception involves processes of neural resonance, motor planning, and musical expectancies which have embodied effects. Most of the time these effects are very subtle, and only detectable by physiological measures such as skin conductance response. Several researchers have proposed objective measures that can be used to quantify the relative power of structural properties of the music on these diffuse affective responses, and to establish the thresholds between non-noticeable responses and noticeable ones. For example, Egermann *et al.* (2013) used an objective measure of musical unexpectedness in melodies based on Pearce and Wiggins' computational model (2006); Farbood (2012) developed a model that predicts patterns of experienced musical tension; Witek *et al.* (2014), Parncutt (1994), Lee & Higgins (1984) have developed models that predict beat and syncopation salience, which can be used to predict listeners' feelings of an urge to move to the rhythm (Witek *et al.*, 2014); and Coutinho and Cangelosi (2011) have developed a computational model that predicts listeners' physiological responses from psychoacoustic parameters in the music.
2. On other occasions, the musical materials elicit more consciously-available changes, such as feelings of tension, startle reflexes, or urges to move-along to the rhythm. When a listener is asked to reflect on these embodied sensations, they report them as feelings that the music is more "emotional", more "tense", "groovier" or that they are having a more intense emotional response (Dibben, 2004; Janata *et al.*, 2012; Steinbeis *et al.*, 2006).
3. The mechanisms of musical expectancies, rhythmic entrainment, brain stem reflexes, and of bodily adaption to musical tension and intensity, lead only to fluctuations in arousal and, possibly, but to a lesser extent, also of valence. (This hypothesis is tested in chapter six). These mechanisms can lead to the induction of full-blown emotions only with the participation of "conceptual" mechanisms based on associative processing and rule-based appraisals.
4. Since the perception of music and of music expressivity of emotion is supported by mechanisms of embodied simulation, then manipulating the listeners' embodied states can facilitate or hamper the perception and the induction of musical emotions. (This hypothesis is tested in chapters seven and eight).

5. The changes in core affect induced by music interact with mechanisms that provide conceptual information (i.e. associations and appraisals) producing a variety of emotional responses. Although this variety tends to be limited by the levels of arousal and valence expressed and induced by the musical sounds, they are not restricted to a reduced set of so-called basic emotions; not even in the absence of an immediate meaningful social context (such as in the context of an experiment). (See chapters seven and eight for new empirical evidence for this claim).
6. Even though associative mechanisms (such as the activation of semantic knowledge and the presence of narratives) increase the probability of having an emotional response to music, this probability depends on how personally specific the activated associations are. The more personal the associations, the more likely the listener will experience an emotion. (Importantly, assuming that some associations have personal relevance does not imply that they become accessible to consciousness while the person listens to the music).
7. In the same sense, when several mechanisms of induction are activated at the same time, those mechanisms more directly related to the activation of personal meanings will tend to dominate.
8. Extra-musical factors such as programme notes, lyrics and visual images tend to be more powerful the more they constitute narratives. Their effects, however, interact with the core affect specified by the musical material: the more congruent they are, the more powerful the effect of this extra-musical information.
9. Given the cultural-relative character of some of the associative mechanisms (such as the activation of semantic knowledge, or the familiarity with the musical conventions), people from different cultural backgrounds have qualitatively different emotional experiences when they listen to the same piece of music. They have, however, some level of agreement in their responses, related to the level of arousal expressed and induced by the music.
10. The quality and specificity of the affective response that a listener has from listening to a piece of music depends on the mode of attention they dedicate to the music, and to its personal and cultural connotations. The more a listener engages in a deep, engaged mode of listening, the more she will construct emotional meanings, and therefore, the more likely she will have a discrete emotional reaction to the musical event.

5.7 Conclusion

In this chapter I have presented a constructionist theory of induction of emotions by music, integrating the proposals from several of the constructionist theories of emotion that I described in the previous chapter, and particularly, from Barrett's Conceptual Act Theory.

In my view, my proposal overcomes some of the shortcomings and difficulties that I identified in other contemporary theories in the first chapters. Nevertheless, it is evident that my proposal does not represent a paradigmatic revolution in the Kuhnian sense (Kuhn, 1962). On the contrary, I consider that my theory builds upon the claims of the BRECVEMA and the Multifactorial theories, integrating and re-interpreting their proposals, and at some points, contradicting them. Given the limitations of space, I leave the critical evaluation of my proposal for the Conclusions chapter. There, I analyse how my theory answers the main questions that every emotion theory should answer (see section 1.4 of Chapter 1, and Moors, 2009), and I evaluate the main differences and similarities between my theory and the BRECVEMA theory, and the Multifactorial Process Model.

6. Does rhythmic entrainment lead to changes in affective state?

Sometimes we find the urge to move in time with music not only irresistible, but also pleasurable, especially when we listen to “groovy” music, which is characterized by marked and complex syncopated rhythms such as soul, funk, hip-hop, electronic dance music, and salsa (Janata *et al.*, 2012; Madison, 2006). This phenomenon is not restricted to Western music: ethnomusicologists have documented how numerous cultures around the world use repetitive drumming patterns and movements to facilitate altered states of consciousness (e.g. Becker, 2010; Eliade, 1964; Rouget, 1985); and recently, Zentner and Eerola (Zentner & Eerola, 2010a) found that infants as young as 5 months of age move spontaneously to music. Nevertheless, in spite of a long tradition of research on the cognitive mechanisms that underlie rhythm and metre perception (Large & Jones, 1999; London, 2012; Parncutt, 1994), the link between synchronization of movements to music and emotional experiences has been neglected, and only recently has it become an object of empirical research. This paper aims to fill this void, by presenting experimental evidence of affective experiences while moving in time with music that contains only rhythmic information.

This phenomenon of synchronization, or sensorimotor coupling with music has been called “rhythmic entrainment”, a term taken from Physics, where it refers to “the tendency for rhythmic processes or oscillations to adjust in order to match other rhythms” (Will & Turow, 2011, p. 6). In the case of music, the coupling of a person’s bodily rhythms to the music can occur at different levels, depending on the subsystems involved. Thus, Trost and Vuilleumier (2013) distinguish between four phenomena: *perceptual entrainment*, in which neural firing patterns become synchronized with the hierarchical structure of the musical beats, producing the perception of rhythm;

physiological entrainment, whereby cardiovascular and respiratory patterns change in response to aspects of the musical structure, such as tempo (Khalfa, Roy, Rainville, Dalla Bella, & Peretz, 2008); *social entrainment*, which occurs when several individuals coordinate their movements to dance or make music together; and *motor entrainment*, in which overt bodily movements (of the limbs, the head, the fingers, etc.) are synchronized with aspects of a musical rhythm.

Rhythmic entrainment is intrinsically related to the rhythmic complexity of the music. Music with periodic rhythmic patterns affords the perception of metre, which in turns facilitates the listener's synchronization. The opposite happens when music contains high levels of syncopation, that is, when it contains frequent musical events that fail to occur in a strong metric position (Huron & Ommen, 2006; Witek *et al.*, 2014). This type of music violates the listeners' expectations, hindering the perception of metre, and their ability to synchronize their movements to the music (Fitch & Rosenfeld, 2007; Janata *et al.*, 2012). Perhaps paradoxically, recent research has found that music characterised by having moderate levels of syncopation is experienced as more "groovy", that is, as inducing a desire to move along to it (Witek *et al.*, 2014).

In recent years, researchers have started to investigate the relation between music-induced movement and listeners' affective experience. For instance, Maes & Leman (2013) showed that teaching children to dance a "sad" or a "happy" choreography to ambiguous music biases their perception of the emotion expressed by the music accordingly; and a team of researchers at the University of Jyväskylä have started to map the way the emotions we perceive in music, our musical preferences, and our current emotional state are reflected in the way we dance to music (e.g. Luck, Saarikallio, Burger, Thompson, & Toiviainen, 2014; Saarikallio, Luck, Burger, Thompson, & Toiviainen, 2013). In contrast, the possibility that music-induced movement leads to induced affective experiences has received less attention. Hence, the question about whether moving in time with music induces changes in the affective state of the listener, remains unanswered. Abundant evidence suggests that that the answer should be "yes": ethnographic studies on musical cultures have found that people derive pleasure from dancing in public spaces such as clubs and concerts (e.g. Malbon, 1998; Waxer, 2002), intervention studies have shown that dancing brings beneficial effects to people suffering from depression (Koch, Morlinghaus, & Fuchs, 2007) and to elderly adults (e.g. Alpert *et al.*, 2009; Hui, Chui, & Woo, 2009); and a recent psychophysiological study has shown that partner-dancing to tango has positive affective and hormonal effects

(Quiroga Murcia, Bongard, & Kreutz, 2009). Nevertheless, since none of these studies attempted to control the factors that interact in these positive experiences of moving to music (e.g. the live or recorded character of the music, the presence of a partner and other people, the characteristics of venue and the social occasion, the consumption of alcohol, etc.), they cannot really account for the specific contribution of *musical sounds* in these pleasurable experiences, nor they can illuminate the underlying *psychological mechanisms* therein involved.

Two types of theories have been proposed to explain the link between movement, entrainment, and pleasure. The first type proposes that rhythmic entrainment with music induces changes in listeners' *arousal* and/or *valence* levels, rather than discrete emotional states; a proposal which implies that, as Barrett and colleagues have suggested (Barrett, Mesquita, Ochsner, & Gross, 2007; Barrett, Mesquita, & Smith, 2010; Barrett, 2006b), these low-level affective changes can become discrete emotions given the presence of a relevant context. In contrast, the second type of theories proposes that rhythmic entrainment induces discrete emotions related to feelings of *social bonding*. From the first perspective, Juslin and Scherer have proposed that rhythmic entrainment leads to feelings of *increased arousal* through a process of *spreading of activation*, whereby physiological responses such a heart rate and respiration lock in to a common periodicity with music, and this activation in turn propagates to other components of the emotional system (Juslin et al., 2010; Juslin & Västfjäll, 2008; Scherer, 2004; Scherer & Coutinho, 2013). And from a neurophysiological perspective, Trost and Vuilleumier (2013) propose that music can induce feelings of *pleasantness*, since several motor pathways in the brain (like the basal ganglia, the cerebellum and the supplementary motor area) are consistently implicated both in rhythm perception and in pleasurable responses to music. From the second theoretical perspective, and also drawing from neuroscience, Overy and Molnar-Szakacs (2006) have suggested that music listening activates the mirror neuron system, which simulates the actions required to produce the heard sounds; consequently, this simulation mechanism induces a strong sense of being together with other human beings who produce the musical sounds. The implication is that these pleasant *feelings of communion* and *affiliation* would be intensified when the listener also synchronizes her own movements with the music, or with other people moving in time with it (e.g. Hove & Risen, 2009; Tarr, Launay, Cohen, & Dunbar, 2015). Finally, drawing from an evolutionary perspective, Ian Cross (Cross, 2009) has proposed that musical entrainment has the adaptive function of communicating the individual's intention to cooperate with the other people engaged in the musical event. Along similar lines, Juslin has also suggested that rhythmic entrainment may arouse "feelings of communion", "feeling connected" and "emotional bonding" (Juslin, 2013b).

Recent studies have found that listeners' ratings of groove (the extent to which a piece of music compels one to move), show considerable consistency (Madison, 2006); and that the groovier the music, the more people enjoy it (Janata *et al.*, 2012). However, contrary to what could be expected, Janata *et al.* also found that participants' enjoyment of the music was hampered by the requirement to tap along to it, and that they preferred to simply listen to it.

This result seems to contradict the findings of two other recent studies that have tested the hypothesis that rhythmic entrainment induces feelings of pleasure. Labbé and Grandjean (Labbé & Grandjean, 2014) asked participants to listen to nine pieces for solo violin and to rate their feelings of being physically stimulated, of wanting to move along, their experience of being emotionally affected, and their emotional reactions along the nine dimensions of the Geneva Music Scale (GEMS) (Zentner et al., 2008). They found that the participants' answers to the entrainment questionnaire rendered a two-factor solution: a *Visceral Entrainment* factor, constituted by items related to feelings of internal bodily agitation (e.g. "to what extent did you feel your own body resonate with the music?"); and a *Motor Entrainment* factor, constituted by items related to the desire to move in time with the music (e.g. "to what extent did you feel like dancing?"). Both factors were significantly related to the GEMS dimensions of Joyful activation, Transcendence, Wonder, Power, and Tenderness; but only *Visceral Entrainment* correlated with self-reported Nostalgia and Sadness, whereas only *Motor Entrainment* correlated with self-reported Peacefulness. Furthermore, both factors predicted the extent to which the participants reported feeling "moved" or "affected" by the piece, a finding that supports Juslin's and Scherer's hypotheses that entrainment leads to feelings of general arousal. Labbé and Grandjean, however, propose a different interpretation; for them, although entrainment is often related to positively valenced and arousing emotions, entrainment is best understood as a bidimensional phenomenon, in which each dimension contributes to the induction of a different set of discrete emotions.

Witek and colleagues (Witek *et al.*, 2014) also found a positive association between listeners' urge to move to music and the induction of pleasure in their study. These researchers asked participants to listen to 50 drum-breaks with different levels of syncopation, to rate their feelings of wanting to move along to the rhythm, and the amount of pleasure they experienced. The results showed an inverted U-shaped relationship between the degree of syncopation of the stimuli and the participants' affective experience, so that the stimuli with medium degrees of syncopation elicited the most desire to move and the most pleasure. Based on Berlyne's psychobiological theory of aesthetics (Berlyne, 1971), and on theories of musical expectation (Huron, 2006; Meyer, 1956), Witek and colleagues suggest that the urge to move and the pleasure associated with "groovy" music is caused by an optimal tension between the realization and the violation of metrical expectations. Thus, music with low degrees of syncopation facilitates metre perception and sensorimotor synchronization, but offers few opportunities to surprise the listener with violations of expectations, and to trigger the process of positive appraisal described by Huron (2006). Music with high levels of syncopation, in which few expectations are generated and confirmed, disrupts the perception of metre, makes synchronization difficult, and offers even fewer opportunities for pleasure elicitation. In contrast, groovy music, characterised by having a medium degree of syncopation, provides an optimal balance between violated and realized expectations, and "invites" the listener to "enact" the missing beats by moving her body in a beat-directed fashion. For Witek and colleagues, these feelings of enacting the missing beats with bodily movements are in themselves pleasurable.

Despite the significance of these contributions, none of these studies unequivocally demonstrates that rhythmic entrainment leads to affective changes in listeners. First, both Labbé's and Witek's experiments studied the participants' feelings of desire to move to the music, but they did not ask the participants to move along with it. It is possible that other factors involved in performing actual movements interfere in the affective experience of the listeners when they try to move in synchrony with the music. Second, neither Janata *et al.* nor Labbé *et al.* controlled the influence of other musical parameters in their participants' experience (e.g. melody, harmonic progression, articulation, etc.), and therefore, there is no way of knowing whether the pleasurable feelings of being compelled to move to the music that they observed were driven by the rhythmic aspect of the stimuli or by other features. And finally, even though I agree with Labbé and Grandjean's theory that the feelings of inner bodily agitation constitute a central aspect of people's musical experiences that had been previously neglected, I consider it misleading to categorise these "visceral feelings" as a form of "entrainment"; there is nothing in their data to indicate if there were any internal cyclical physiological processes in the participants' bodies which became synchronized with the rhythm of the musical pieces. Perhaps it would be better to regard these subjective experiences as examples of virtual self-motion, that is, illusory sensations of one's own body moving in an imaginary environment, thanks to the ability of music to specify movement (Bharucha, Curtis, & Paroo, 2006; Clarke, 2005).

6.1 Overview of the present study

The purpose of this study is to examine whether motor entrainment induces positive affect, and how this phenomenon interacts with the level of syncopation of the musical stimulus. For this, participants listened to drum-breaks that varied in their level of syncopation (low, medium, high). One group of participants was asked to listen to the music staying completely still (*stationary condition*), and another group to tap along with one foot to the pulse of the music (*tapping condition*). This is the first time, to my knowledge, that this phenomenon has been studied asking participants to produce overt movements to the music, and using musical stimuli which contain only rhythmic information (i.e. there were no variations of tempo, timbre, micro-timing, and no melodic nor harmonic elements present in the drum-breaks).

The study investigated three competing hypotheses. The first is based on research that has found that the urge to move in time with music is pleasurable, (Janata et al., 2012; Trost & Vuilleumier, 2013; Witek et al., 2014), from which it can be inferred that realizing that urge will feel more pleasurable than refraining from it. Consequently, I hypothesised that participants who tap along with the beat would experience overall more *positive valence* (i.e. pleasure) than participants who remain still; and that this change in experienced valence would be larger than the changes in experienced tense arousal (i.e. subjective feelings of relaxation/tension) and energetic arousal (i.e. subjective feelings of wakefulness/sleepiness) (**Hypothesis 1P**). Alternatively, based on Juslin and Scherer's theories about how rhythmic entrainment induces affective changes in the listener thanks to increased arousal (Juslin, 2013; Scherer & Coutinho, 2013), I hypothesised that participants in the "tapping" condition would experience more tension (i.e. tense arousal), and higher levels of energy (i.e. energetic arousal) than participants in the “stationary” condition. Furthermore, I also predicted that the effects of listening condition (listening while tapping vs. listening remaining stationary) on arousal ratings would be larger than the effects on pleasantness ratings (**Hypothesis 1T and 1E**).

Concerning the effect of syncopation, three hypotheses were tested. Firstly, following Witek and colleagues’ hypotheses and findings (Witek *et al.*, 2014) I predicted that in both groups of participants the relationship between the degree of syncopation of the stimuli and the experience of pleasantness would have an inverted U-shape such that stimuli with a medium-level of syncopation would be associated with more pleasure than stimuli with low and high levels of syncopation (**Hypothesis 2P**). Secondly, based on Huron’s musical expectations theory (2006), I predicted that the participants’ experience of tension and energy would increase with the degree of syncopation of the music, so that stimuli with low-syncopation levels would be associated with the highest relaxation and sleepiness ratings, and stimuli with high-syncopation levels would be associated with the highest tension and wakefulness ratings (**Hypotheses 2T and 2E**).

As for the interaction effects, it was hypothesised that since tapping along with high-syncopated stimuli would be experienced as more difficult than tapping along with low and medium syncopated stimuli, this would lead to the induction of more intense negative affective states. Particularly, it was predicted that when listening and tapping along with highly syncopated stimuli, participants in the *tapping* condition would experience less pleasantness (**Hypothesis 3P**), more tension (**Hypothesis 3T**) and more energy (**Hypothesis 3E**), than participants in the stationary condition, who listened to this stimuli without moving.

Table 6.1 *Summary of experimental hypotheses*

Effect of listening condition	**Hypothesis 1P**	Tapping leads to more pleasure than listening without moving.
	Hypothesis 1T	Tapping leads to more tension (i.e. tense arousal) than listening without moving.
	Hypothesis 1E	Tapping leads to more wakefulness (i.e. energetic arousal) than listening without moving.
Effect of syncopation level	**Hypothesis 2P**	Inverted U shape relationship between syncopation and pleasure.
	Hypothesis 2T	Tension increases with syncopation: the more syncopated the stimuli, the more experienced tension (i.e. tense arousal)
	Hypothesis 2E	Wakefulness increases with syncopation: the more syncopated the stimuli, the more experienced wakefulness (i.e. energetic arousal).
Interaction effects	**Hypothesis 3P**	Tapping along with highly syncopated stimuli leads to more displeasure than listening without moving to highly syncopated stimuli.
	Hypothesis 3T	Tapping along with highly syncopated stimuli leads to more tension (i.e. higher ratings of tense arousal) than listening without moving to highly-syncopated stimuli.
	Hypothesis 3E	Tapping along with highly syncopated stimuli would lead to more wakefulness (i.e. higher ratings of energetic arousal) than listening without moving to high-syncopated stimuli.

6.2 Method

6.2.1 Participants

Seventy six participants aged between 18 and 63 (Mean = 29.75, SD = 10.87, 55 Women) took part in the experiment. They were recruited on a voluntary basis from the city and the University of Sheffield, UK. Participants were randomly assigned to two conditions: a tapping condition or a stationary condition. There were 36 participants in each condition.

The level of musicianship of the participants was measured using two scales from the Goldsmith's Musical Sophistication Index [Gold-MSI] (Müllensiefen, Gingras, Stewart, & Ji, 2013). The participants' scores in the *Musical Training* scale ranged from 7 to 48 (the minimum possible score is 7, and the maximum 49), with a mean of 27.18 (SD = 12.25). The participants' scores in the *Music Engagement* scale ranged from 12 to 60 (the minimum possible score is 9, and the maximum 63), with a mean of 39.64 (SD = 9.65). These scores suggest that overall, the participants had similar mean levels of musicianship (and SD's) to those of the general population ($M_{training}$ = 26.52, SD = 11.44;

$M_{engagement}$ = 41.52, SD = 10.36), as documented by Müllensiefen *et al.* (Müllensiefen *et al.*, 2013)[22].

Due to the relevance for the objectives of the experiment, I also measured the participants' level of engagement with dance-related activities, using a 5-items ad-hoc questionnaire. The participants' scores ranged from 8 to 33 (the minimum possible score was 5, and the maximum 33), with a mean of 23.34 (SD = 5.89). More than 90% of the participants had scores above the mid-point of the scale (i.e. above 14 points). Also of importance, 80.3% of the participants reported listening to and frequently enjoying groovy musical styles (such as Funk, Soul, and Rap). These data indicates that in general, the participants had a high level of engagement with dancing and of familiarity with syncopated musical genres. Importantly, no differences between the groups were observed in any of these variables.

6.2.2 Design

The experiment used a mixed design, with 'movement' as the between-subjects independent variable (two levels: *Tapping*, *Stationary*); *Syncopation Level* as within-subjects independent variable (three levels: Low, Medium, High), and *Valence*, *Tense Arousal* and *Energetic Arousal* as dependent variables.

6.2.3 Stimuli

The musical stimuli consisted of 6 drum-breaks selected from a set of 50 developed by Maria Witek for a previous experiment. The stimuli were programmed in GarageBand 5.1 (Apple, Inc.) using a synthesised drum-kit (bass-drum, snare-drum and hihat). The stimuli were in 4/4 metre, with syncopations occurring within the bass-drum and snare drum parts at the quaver and semi-quaver level of the meter, while the hihat remained at a constant quaver pulse. None of the stimuli included variations in microtiming. Every drum-break lasted 32 seconds, and consisted of a two-bar phrase looped eight times at 120 bpm –a tempo within the range of tempi where synchronization is facilitated (Leman *et al.*, 2013). (See Figure 6.1 for notational transcriptions).

---

[22] The participants are in the 50th percentile in the Training scale, and in the 40th percentile in the Engagement scale, according to the norms published by Müllensiefen *et al.* (2013).

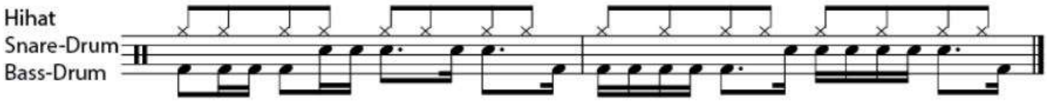
The stimuli were chosen according to their degree of syncopation, and the mean ratings of induced pleasure and of motivation to move reported by the participants in Witek and colleagues' study (Witek *et al.*, 2014). Thus, the *low syncopation stimuli* in this experiment have syncopation degrees, ratings of motivation to move, and ratings of induced pleasure at least one standard deviation below the mean values obtained in Witek's experiment; the *high syncopation stimuli* have ratings at least one standard deviation above the mean values; and the *medium syncopation stimuli* have ratings within 0.5 standard deviations above or below the mean values.

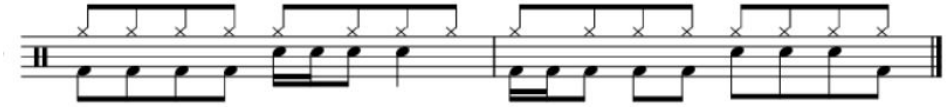
The degree of syncopation of the drum-breaks was calculated using an index of syncopation also developed by Witek. This index, based on Longuet-Higgins and Lee's model (Longuet-Higgins & Lee, 1984), uses instrumental weights, and a less hierarchical model of metre to account for the differences between rests and notes, and for the differences between notes played on different instruments of the drum-kit (for details, see Witek *et al.* 2014). Importantly, even though the stimuli differ in the number of onsets, they have an equivalent level of acoustic complexity, as measured by an index called "Joint Audio Entropy". This index measures the probability that each wave sample occurs on the basis of the distribution of the wave data as a whole (Witek *et al.*, 2014). Thus, all the stimuli in this experiment had a degree of complexity within one standard deviation below or above the mean rating of entropy observed in Witek and colleagues' set of 50 stimuli. (Table 6.2 shows the values corresponding to each stimulus).

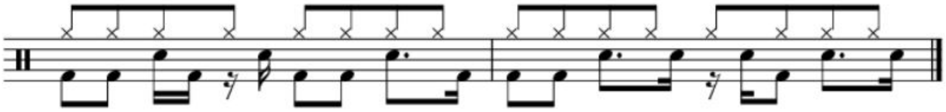
Table 6.2 *Audio properties stimuli and mean scores of urge to move and pleasure in Witek and colleagues' study (2014)*

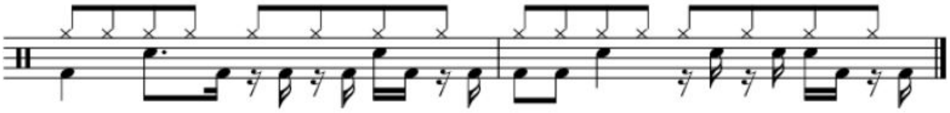
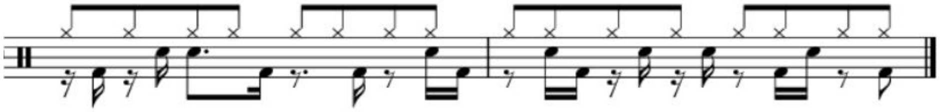
	Low Syncopation		**Medium Syncopation**		**High Syncopation**	
Stimuli	**1**	**2**	**3**	**4**	**5**	**6**
Syncopation degree	0	8	34	43	62	58
Joint Audio Entropy	12.72	12.17	12.41	12.32	11.68	10.63
Number of strokes (onsets)	22	17	17	16	15	9
Mean rating of *Wanting to move*	2.27	2.15	3.45	3.21	1.98	1.94
Mean rating of *Pleasure*	2.21	2.30	3.35	3.20	2.12	2.24

Stimulus 1: Low syncopation



Stimulus 2: Low syncopation

Stimulus 3: Medium syncopation



Stimulus 4: Medium syncopation

Stimulus 5: High Syncopation

Stimulus 6: High Syncopation

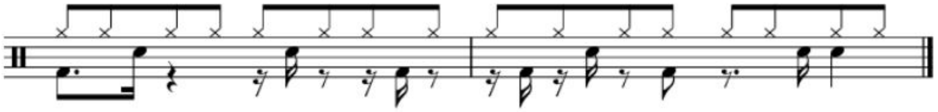



Figure 6.1. Notational transcriptions of stimuli.

6.2.4 Measures

The participants' affective state was assessed using one indirect and one direct measure. The indirect measure was developed based on theories of emotion-congruence (e.g. Bower, 1981) and of emotional misattribution in the perception of faces (e.g. Niedenthal, Halberstadt, & Margolin, 2000; Walbott, 1991), according to which the current affective state of an observer biases her perception of other people's emotional expressions in a congruent manner. In this experiment, the technique consisted in asking the participants to rate the pleasantness expressed by photographs depicting affectively ambiguous facial expressions by using a 7-point Likert scale ranging from "very bad" to "very well". This technique was created following a similar procedure to that used by Niedenthal *et al.* (2000): I took pictures from the FACS (Ekman & Friesen, 1978) and from the ADFES (Van der Schalk, Hawk, Fischer, & Doosje, 2011) which showed an expression of joy and an expression of anger or disgust, and by using a video-morphing software (Sqirlz Morph 2.1 Xiberpix), I created images displaying a "blended" facial expression which contained elements of both extremes (Figure 6.2). It was expected that participants who experience a negative affective state would perceive the ambiguous faces as expressing a more negative affective state than participants who experience a positive affective state, and vice versa; and therefore, that the participants ratings of perceived affect would work as a proxy measure of their own valence.

The participants judged a total of 14 facial stimuli (2 during base line, and 2 per trial during 6 trials). This set of pictures was chosen out of an initial set of 70 which were pre-tested with a web-based questionnaire in which 223 English-speaking participants and 50 Spanish-speaking participants were asked to report their affective state, and to rate the valence expressed by each photo. The chosen stimuli were the ones with the highest correlation coefficients between the participants' self-reported valence and their ratings of attributed valence to the photo.

In order to hide the true objective of the experiment from the participants, I used the same morphing technique to develop an additional set of 14 ambiguous facial stimuli in which it was difficult to tell the gender of the person in the photo, and asked the participants to decide to what extent they perceived the person to be male or female. These answers, however, were not analysed because they were not relevant for the purpose of the study.

The direct measure of affect consisted in questionnaires of self-report of valence and of arousal. Following Schimmack and Grob's recommendations (Schimmack & Grob, 2000), *arousal* was defined as composed by two dimensions: *tension arousal* (varying in degrees of relaxation-tension), and *energetic arousal* (varying in degrees of wakefulness-tiredness). Thus, after each trial the participants rated their affective state with 6-items using 4-point Likert scales (1 = I do not feel…, 4 = I feel very… *pleasant* (positive, good); *unpleasant* (negative, bad); *awake* (alert, wakeful); *sleepy* (tired, drowsy); *relaxed* (at rest, calm); *tense* (restless, jittery)). All items were rated on unipolar scales, which were transformed into bipolar scales by subtracting ratings of the positive pole from ratings from the negative pole.

6.2.5 Procedure

The experiment was conducted individually. When participants arrived at the laboratory they were seated in a comfortable chair in front of a desk with a computer screen, and after reading and signing the consent forms, they received the following instructions on the screen:

> Welcome. During the experiment, you will be asked to do two simple perceptual tasks, to listen to short pieces of music, and to answer a few questions related to your listening experience. You will repeat this procedure several times.

Then, they received the following instructions for the ambiguous faces task, and did a practice trial:

> In this task, you will look at a photograph of a person, and you have to decide how that person is feeling. You must do this as quickly as you can.

Afterwards, they received the instructions for the gender-ambiguous faces, and did a practice trial as well:

> In this task, you will look at a photograph of a person, and you have to decide whether that person is male or female. Again, you must do this this as quickly as you can.

At this point, the experimenter gave the following instructions to the participants in the Tapping condition:

> During the experiment, you will listen to several short musical excerpts. When you listen to the music, please tap along to the beat, using your foot, in a regular and comfortable way. You can take a few moments to listen before starting tapping.

The participants in the Stationary condition received the following instruction:

> During the experiment, you will listen to several short musical excerpts. When you listen to the music, all you have to do is to stay as still as possible. You don't need to tense your body, but please try not to move at all while the music is playing. (These participants were reminded to remain still whenever the experimenter noticed that they had started to move along to the music).

All the musical stimuli were presented through headphones (Bose AE2), and the listener could adjust the sound level for comfort[23]. The ambiguous faces stimuli and the participants' responses were presented and recorded using a computer interface programmed in OpenSesame 2.8.1. Each stimulus was presented once to each participant, in a counterbalanced fashion.

Immediately after the last trial, the participants responded to a questionnaire about their demographic information, musicianship, and engagement in dancing activities. After this, they were debriefed and thanked for their participation.

Figure 6.2 Example of ambiguous facial stimulus used in the experiment, created from two opposite emotional expressions.

---

[23] Even though the different levels of loudness that the participants chose might be associated with higher or lower levels of induced arousal, it was decided that what each individual perceived as "appropriate level of loudness" was more important, because in in this way, all the participants had equivalent levels of comfort. In fact, very few participants asked to change the initial default level of loudness.

6.3 Results

6.3.1 Judgement of Facial Stimuli

The indirect measurement technique was based on the assumption that the participants' own affective state would bias their perception of facial stimuli displaying ambiguous affective expressions (Niedenthal *et al.*, 2000). Hence, it was predicted that participants in a positive affective state would perceive the ambiguous faces as expressing more positive valence, and participants in a negative affective state would perceive them as expressing more negative valence.

I tested the validity of this technique by running non-parametric correlation analyses between the participants' ratings of valence expressed by the faces and their self-reported affective state (n = 75). All the correlations with self-reported valence, except one, were positive; but the coefficients are small (they range from -.13 to .32) and only 3 (out 14) correlations are statistically significant. The correlations with self-reported relaxation were all positive, they range from .02 to .40, and 4 of them are significant. Ten of the correlations with self-reported energetic arousal were negative, they range from -.11 to .32 and only one of them is statistically significant. (See Table 6.4 for detailed information on correlation coefficients and p-values).

The frequency distribution of the ratings of perceived valence in the ambiguous stimuli reveals that the participants had a negative bias when judging the ambiguous faces: the mean observed skewness is 0.28. (See Table 6.3 for a summary of the descriptive statistics)

Taken together, these results indicate that there was wide inter-subjects variability in the ratings of perceived pleasantness in the facial stimuli, and that not all the stimuli were equally successful in displaying the predicted congruence effect.

Despite these important limitations regarding the validity of the ambiguous faces technique, it was still possible that the participants' judgements showed the predicted trends, so I tested the effects of the independent variables on these scores by running a mixed ANCOVA with *syncopation* (3 levels) as the within groups factor, *listening condition* (2 levels) as the between groups factor, and *base line scores* as covariate. Given that it is unclear at this point how long the misattribution effect lasts, and to what extent the perception of the first face in each pair has an effect on the perception of the second face, I performed two analyses: one for the first facial stimulus of each pair, and one for the second.

In the case of the *first of the two ambiguous faces*, contrary to the expectation of a positive effect of movement on experienced pleasure (Hypothesis 1P) there was no significant main effect of *listening condition* (Stationary/Tapping) on the participants' judgements of the faces F(1, 71) = .423 p = .518. Regarding the prediction of an association between syncopation level and pleasure (Hypothesis 2P), there was a marginally significant main effect of *syncopation level* on participants' judgements F(2, 142) = 2.7837 p = .062. Although these effects were in the predicted direction (i.e. showing an inverted U shaped trend), only the differences between low syncopated and medium syncopated effects were statistically significant: F(1, 71) = 6.153 p = .015, effect size r = .28; with the low syncopated stimuli associated with less positive ratings. The polynomial contrasts tests also suggest that these results fit a quadratic trend better than a linear one $F_{quadratic}(1,71) = 4.459$ p = .038; $F_{linear}(1, 71) = .891$ p = .348. Regarding the prediction that the highly syncopated stimuli would be associated with higher displeasure in the tapping condition (Hypothesis 3P), there was no evidence of this interaction: F(2, 142) = .792 p = .455. (Table 6.6 shows the means and standard deviations for all these analyses, and Figure 6.3 displays the effects of listening condition and syncopation on perception of the first ambiguous faces).

The participants' ratings for the *second ambiguous face* did not produce the predicted pattern of results: no significant main effect of *listening condition* (Stationary / Tapping) was observed (Hypothesis 1P), F(1, 72) = .014 p = .905. The main effect of *syncopation level* on the participants' judgements (Hypothesis 2P) was also non-significant, F(2, 144) = 1.377 p = .256. And there was no significant interaction between *listening condition* and *syncopation level* (Hypothesis 3), F (2, 144) = .097 p = .908. (Means and standard deviations in Table 6.5, and a summary of the effects of listening condition and syncopation on perception of the second ambiguous faces in Figure 6.4).

Table 6.3 *Descriptive statistics for ratings of valence attributed to ambiguous facial stimuli*

	Mean	**Standard Deviation**	**Skewness**	**Kurtosis**
Face1	-1.51	1.31	1.61	3.00
Face2	-0.12	0.75	0.20	2.16
Face3	0.56	1.69	-0.23	-1.44
Face4	0.89	1.61	-0.56	-0.81
Face5	0.08	1.60	-0.13	-0.97
Face6	0.20	1.41	-0.24	-0.86
Face7	-0.51	1.41	0.22	-0.59
Face8	-0.83	1.26	0.49	0.35
Face9	-0.79	1.53	0.67	-0.19
Face10	-0.92	1.21	0.31	-0.54
Face11	-0.22	1.69	0.23	-1.25
Face12	0.11	1.47	-0.03	-1.07
Face13	-1.36	1.08	1.02	1.41
Face14	-1.22	1.02	0.39	0.15

Table 6.4 *Correlations between perceived valence in facial stimuli and self-reported valence, tense-arousal and energetic arousal*

		Self-Reported Valence	**Self-Reported Tense Arousal**	**Self-Reported Energetic Arousal**
Base Line	Face1	.08	.06	-.09
	Face2	.02	.02	.20
Low Syncopation	Face1	.04	.14	-.03
	Face2	.07	.07	$.32^{**}$
	Face1	.19	.19	.04
	Face2	.03	$.25^{*}$	-.03
Medium Syncopation	Face1	-.01	.09	-.02
	Face2	$.23^{*}$	.08	-.11
	Face1	-.13	.08	-.09
	Face2	$.32^{**}$	$.26^{*}$	-.01
High Syncopation	Face1	.01	.03	.13
	Face2	.21	$.39^{**}$	-.10
	Face1	$.24^{*}$	$.28^{*}$	-.03
	Face2	.16	.16	-.03

N= 76
Correlation Coefficient: Spearman's Rho
* Correlation significant at p <.005
** Correlation significant at p <.001

6.3.2 Self-reports of Core Affect

I tested the effects of the independent variables on ratings of experienced *valence*, *tension,* and *energy* by running mixed ANCOVAs with *Syncopation* (3 levels) as the within groups factor, *Listening Condition* (2 levels) as the between groups factor, and *Base Line Scores* as covariates.

As expected from a three-dimensional model of affect (e.g. Schimmack & Rainer, 2002) all the participants' ratings of *valence* and *tense arousal* had positive and significant correlations (in the scale used, a higher score indicated higher relaxation); while the ratings of *tense arousal* and *energetic arousal* presented a mixture of positive and negative correlations. (None of these correlations was significant, nor larger than .15). This finding suggests that each dimension taps into a different aspect of the participants' affective experience, and that the two ratings of arousal (tension, energy) are not interchangeable.

6.3.2.1 Valence

Contrary to **Hypothesis 1P** which predicted a main effect of movement on valence ratings, there were no significant differences in the participants' ratings of valence in function of their *listening condition* (Stationary/Tapping) F(1, 73) = .150 p = .70 (Table 6.5 shows the means and standard deviations).

Concerning **Hypothesis 2P**, there was a marginally significant main effect of *syncopation level* on the participants' self-reported ratings of pleasantness F(2, 146) = 3.053 p = .050. The observed ratings were in the predicted direction, and the polynomial contrast test supports the hypothesis of a quadratic trend F(1,73) = 6.012 p = .017. (See Table 6.6 for means and standard deviations). However, within-subjects contrast test show that only the differences between high-syncopated and low syncopated stimuli were statistically significant F(1,73) = 6.012 p = .017, effect size r = .28, with the high-syncopated stimuli associated with lower ratings of pleasure than the low-syncopated ones.

Finally, contrary to the prediction in **Hypothesis 3P**, there was no significant interaction between *syncopation level* and *listening condition* F(2, 146) = .826 p = .44. (Figures 6.5, 6.6, and 6.7 display the effects of listening condition and syncopation on valence, and arousal ratings).

6.3.2.2 Tense arousal

Hypothesis 1T was not supported by the data: there was no significant main effect of *listening condition* (Stationary/Tapping) on ratings of experienced *tension* F(1, 73) = .023, p = .881.

Hypothesis 2T predicted an increase of tension associated with an increase in syncopation level. This prediction was supported by the data: a negative linear trend was observed, (suggesting that the more syncopated the stimuli, the less relaxed the participants felt): the polynomial contrast test revealed that the data significantly fit a linear trend, F(1, 73) = 7.4 p = .008; not a quadratic one F(1,73) = 1.404 p = .24. However, the ANCOVA test reveals that this trend was not marked enough to produce differences across all pairwise comparisons F(2, 146) = 4.340 p = .015. Thus, even though stimuli with a *medium level of syncopation* were significantly associated with lower tension ratings than stimuli with a *high level of syncopation* F (1, 73) = 5.945 p = .017, effect size r = .27, there were no significant differences between stimuli with *low* and *medium* levels of *syncopation* F(1,73) = .090 p = .766. (See Table 6.6 for means and standard deviations).

Lastly, **Hypothesis 3T** predicted that tapping along with highly syncopated stimuli would lead to more experienced tension than listening without moving. This interaction was not observed in the data F(2, 146) = .1.059 p = .349. (Figure 6.6 displays the effects of listening condition and syncopation on tension ratings).

6.3.2.3 Energetic arousal

Contrary to the prediction in **Hypothesis 1E**, there was no significant main effect of *listening condition* (Stationary/Tapping) on energetic arousal ratings F(1,73) = 1.83 p = .18. Nor did the results support Hypothesis 2E: there was no significant main effect of *syncopation level* F(2, 146) = .226 p = .798. Hypothesis 3E was not supported by the data either: there was no significant interaction between listening condition and syncopation level F(2, 146) = .269 p = .765. (Tables 6.4 and 6.5 display means and standard deviations, and Figure 6.7 shows the effects of listening condition and syncopation on energetic arousal ratings).

Table 6.5 *Means and standard deviations for perceived affect in ambiguous faces, and self-reported valence, tense arousal and energetic arousal, as a function of listening condition*

	Stationary	**Tapping**
First Ambiguous Face	-0.32 (1.61)	-0.45 (1.65)
Second Ambiguous Face	-0.31 (1.42)	-0.28 (1.47)
Self-reported Valence (pleasure)	1.72 (1.05)	1.71 (1.00)
Self-reported Tense Arousal (relaxation)*	1.33 (1.46)	1.15 (1.21)
Self-reported Energetic arousal (wakefulness)	1.09 (1.13)	1.31 (1.22)

Note: Standard deviations are printed in parentheses.
*Higher ratings indicate higher self-reported relaxation.

Table 6.6 *Means and standard deviations for perceived affect in ambiguous faces, and self-reported valence, tense arousal and energetic arousal, as a function of syncopation level*

	Low Syncopation	**Medium Syncopation**	**High Syncopation**
First Ambiguous Face	-0.48 (1.17)	-0.28 (1.26)	-0.39 (1.17)
Second Ambiguous Face	-0.13 (1.14)	-0.32 (1.07)	-0.43 (1.07)
Self-reported Valence (pleasure)	1.78 (0.87)	1.79 (0.90)	1.59 (0.94)
Self-reported Tense Arousal (relaxation)*	1.23 (1.23)	1.37 (1.19)	1.13 (1.29)
Self-reported Energetic arousal (wakefulness)	1.19 (1.09)	1.18 (1.04)	1.22 (1.08)

Note: Standard deviations are printed in parentheses.
*Higher ratings indicate higher self-reported relaxation.

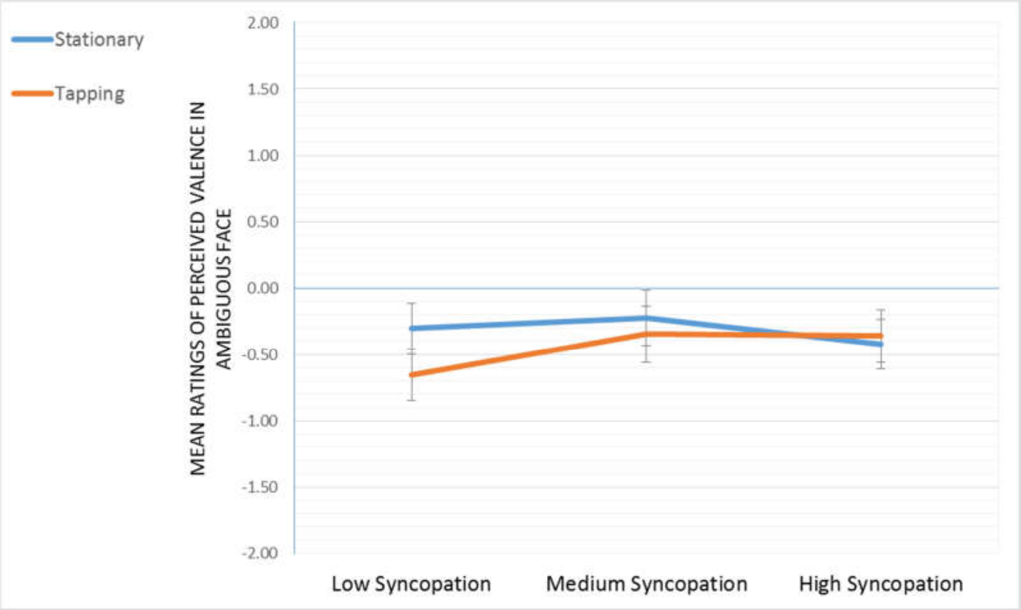


Figure 6.3 Perceived valence ratings in first ambiguous faces as a function of listening condition and syncopation level. (Error bars are standard errors)

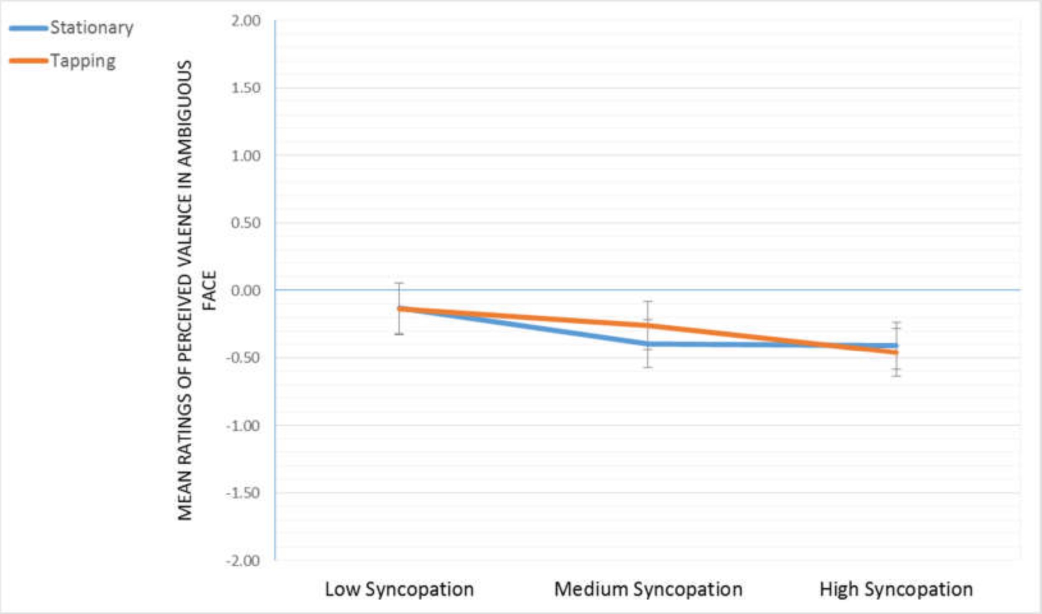


Figure 6.4 Perceived valence ratings in second ambiguous faces as a function of listening condition and syncopation level. (Error bars are standard errors)

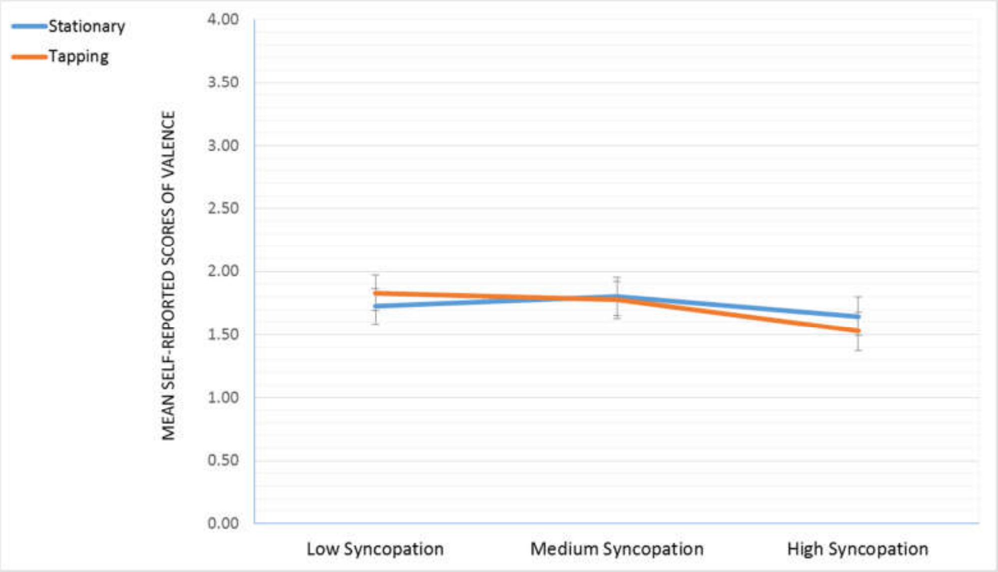


Figure 6.5 Self-reported valence ratings as a function of listening condition and syncopation level. (Error bars are standard errors)

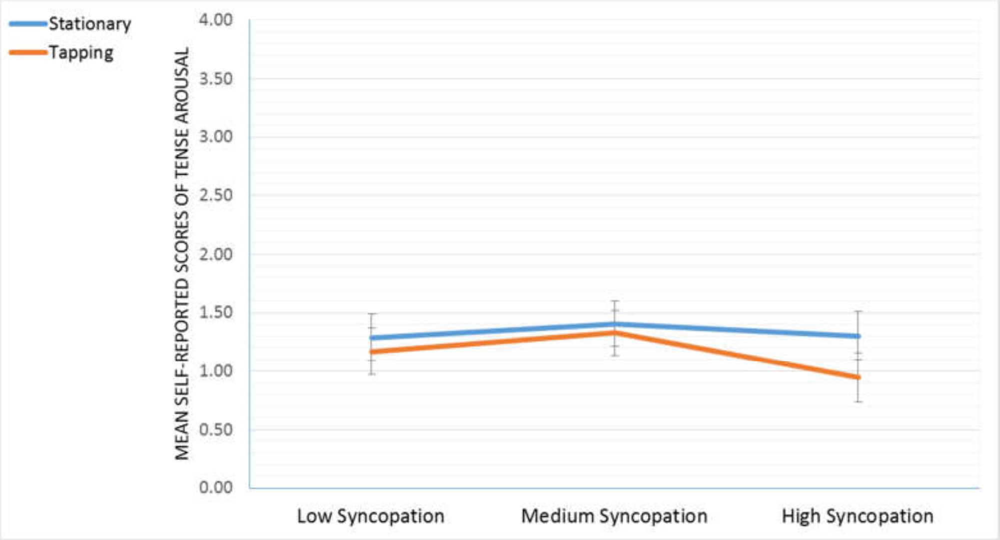


Figure 6.6 Tense arousal ratings as a function of listening condition and syncopation level (Higher ratings represent higher relaxation. Error bars are standard errors)

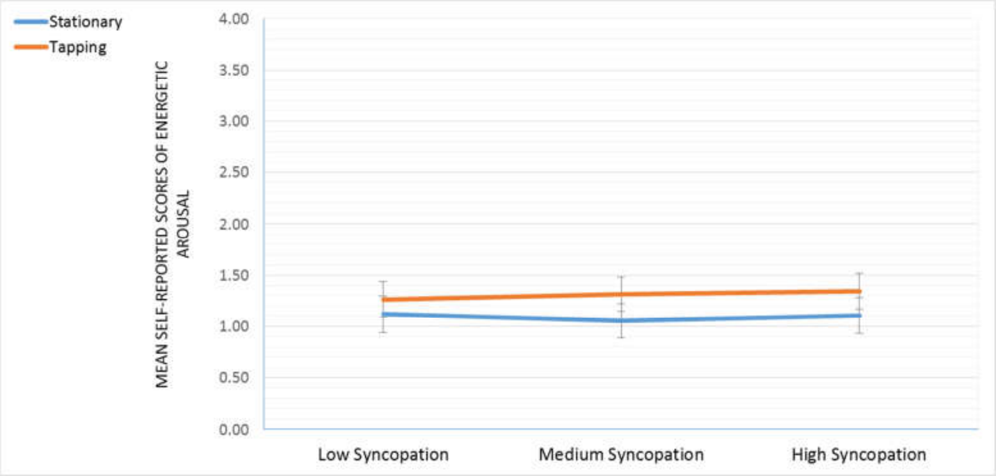


Figure 6.7 Energetic arousal ratings as a function of listening condition and syncopation level (Error bars are standard errors)

6.3.3 Ratings of Perceived Difficulty and Other Mediating Variables

According to Witek *et al.* (2014), an important factor that underlies people's affective responses to groovy rhythms is the interplay between their expectations about when the next rhythmic event is going to sound, and the realization of these expectations in the music. An optimal tension between these two factors leads to increased feelings of pleasure and of wanting to move along with the music. Based on these considerations, I measured two aspects of the participants' experience that could work as mediators between syncopation and their affective responses. I asked participants in the Stationary condition to rate *how difficult they found it to stay still* while listening to the stimuli, and participants in the Tapping condition to rate *how easy they found it to tap along* with the beat. In order to test whether these ratings displayed the predicted trend, I ran one repeated-measures ANOVA per group (Stationary, Tapping), with Syncopation level as the within subjects variable, and difficulty ratings as the Dependent Variable.

In the *Stationary group*, there was a main effect of syncopation on ratings of "*Difficulty to Stay Still*" F(2, 42) = 9.344 p < .000 (Greenhouse-Geisser correction). As predicted, participants reported finding it significantly more difficult to stay still while listening to medium syncopated stimuli than to stimuli with high F(1, 21) = 12.977 p = .002) or low syncopation F(1, 21) = 15.634 p = .001. There were no significant differences between low and high levels of syncopation.

In the *Tapping group*, there was a main effect of syncopation on participants' ratings of "*Easiness to Tap Along with the Beat*" F(2,70) = 47.207 p<.000 (Greenhouse-Geisser correction). Contrasts tests support the prediction, suggesting that the more syncopated the stimuli, the more difficult the participants found it to tap along to them: they reported finding it significantly more difficult to tap along with high syncopated stimuli than with low syncopated ones F(1,35) = 52.718 p<.000, and than with medium syncopated ones F(1,35) = 60.87 p<.000; and easier to tap with medium syncopated stimuli than with low syncopated ones F(1,35) = 4.432 p = .043.

6.3.3.1 Regression analyses: do any variables mediate the observed results?

In the analysis of the results presented so far, I have shown how *listening condition* (tapping vs. stationary) did not produce any significant effects on the measured outcomes, whereas *syncopation level* (low, medium, high) did produce significant effects on self-reported ratings of valence and tense arousal. In this section, I carry out further analysis of the data in order to assess the contribution of several mediator variables in the participants' affective experience.

This analysis consisted of multiple hierarchical regressions with scores of *valence*, *tense arousal* and *energetic arousal* as dependent variables, and as factors: *syncopation level*, *version of stimulus*, *difficulty-to-stay-still/ easiness-to-tap-along*, *musical training*, *engagement in musical activities*, *engagement in dancing-related activities*, and *familiarity with groovy rhythms*. These factors were introduced in each step of the hierarchical regression as follows:

First step: *Syncopation Level*

Second step: *Syncopation Level*
Difficulty-to-stay-still / Easiness-to-tap-along

Third step: *Syncopation Level*
Difficulty-to-stay-still / Easiness-to-tap-along
Musical-Training
Engagement-in- musical-activities
Engagement-in-Dancing-related activities
Enjoyment of groovy music.

Once the significant predictors were identified in each of these models, I ran further analyses including only those identified factors, in order to find the most parsimonious regression equation, and to confirm whether the identified factors still predicted a significant portion variance in the dependent variables, even in the absence of the discarded factors. All confidence intervals were calculated using bootstrap sampling (1000 samples).

In the following paragraphs, I show the results of these regression analyses for each dependent measure, identifying the significant mediating predictors. (See Table 6.7 for a summary of these results).

First Ambiguous Facial stimuli. In the **stationary** condition, the best model explains only 3.3% of the variance in the scores of perceived valence in the first ambiguous face (R^2 = .033, adjusted R^2 = .026). This model contains only the predictor *difficulty-to-stay-still* (Beta = .224) suggesting that the harder the participants found it to stay still while listening to music, the more they experienced pleasure, as measured by the ambiguous face task. In the **tapping condition**, none of the models explains a significant portion of the variance.

Second Ambiguous Facial stimuli. In the **stationary** condition none of the models is significant. In the **tapping condition**, the best model includes one factor, and explains only 2.6% of the variance in ratings of perceived pleasantness in the first ambiguous face (R^2 = .026, Adjusted R^2 = .021): *easiness-to-tap-along* (Beta = .167) suggesting a positive linear relationship between ratings of easiness to tap along and experienced pleasure.

Self-reported valence. In the case of the **stationary** condition, the best model explains, 12.4% of the variance in the scores of self-reported valence. This model indicates that the variables *difficulty-to-stay-still* (Beta = .21) and *dancing-engagement* (Beta = .078), are significant predictors of the variance in *valence* ratings. This suggests that the harder the participants found it to stay still, and the more they are engaged in dancing activities, the more they experienced pleasure.

In the **tapping condition**, the best model includes two factors, and explains 11.8% of the variance in valence ratings: *easiness-to-tap-along* (Beta = .228), and *dancing-engagement* (Beta = .027). This model suggests that the easier participants found it to tap along with the music, and the more they engage in dancing activities, the more they experienced pleasure.

Self-reported tense arousal. In the **stationary condition**, the independence of errors assumption is not met in the model (Durbin-Watson test <1), and none of the factors significantly predicts the variance in self-reports of tense arousal.

In the **tapping condition**, the best model includes the factors: *easiness-to-Tap-Along* (Beta = .228), *dancing-engagement* (Beta = .035), and *enjoyment-of-groovy-music* (Beta = -.283). This model explains 19.3% of the variance. This model suggests that participants' ratings of relaxation increased as the perceived easiness to tap along with the music increased, that participants who engage in dancing activities frequently found the task more relaxing than participants who do not, and that they felt tenser if they were familiarized with groovy music styles.

Self-reported energetic arousal. In the **stationary condition**, the independence of errors assumption is violated (Durbin Watson = .979), and even though *difficulty-to-stay-still* (Beta = .304) appears to be a significant predictor of the variance in energetic arousal ratings, running a regression analysis with only this variable as predictor does not produce a significant model (p > .05).

In the **tapping condition**, the best model includes *musical engagement* (Beta = -.019) and *musical training* (Beta = -.013) as predictors, and explains 5.1% of the variance. This model suggests that the more the participants had musical training, and the more they engaged in musical activities in their everyday lives, the less awake or energized they felt.

Table 6.7 *Summary of regression analyses*

Dependent Variable	Condition	R^2	Sig. Change in R	Significant Coefficients	Beta; CI	Sig. (Beta)
Ambiguous Face 1	Stationary	.033	.037	Difficulty-to-stay still	.22	.017
	Tapping	.010	.153	(None)		
Ambiguous Face 2	Stationary	.044	.419	(None)		
	Tapping	.026	.019	Easy-to-tap-along	.17	.026
Valence	Stationary	.124	.000	Difficulty-to-stay-still	.21	.034
				Dancing engagement	-.08	.003
	Tapping	.118	.000	Easy-to-tap-along	.23	.001
				Dancing engagement	.03	.007
Tense Arousal	Stationary	.067	.493			
	Tapping	.193	.000	Easy-to-tap-along	.28	.001
				Dancing Engagement	.04	.002
				Enjoyment-groovy-music	-.28	.008
Energetic arousal	Stationary	.063	.680	Difficulty-to-stay-still	.30	.047
	Tapping	.002	.001	Easy-to-tap-along	.30	.001
				Musical Engagement	.04	.001
				Musical Training	-.32	.004

6.4 Discussion

This experiment aimed to investigate the relationship between motor entrainment and induced affective states in listeners, by asking participants to listen to musical stimuli with different levels of syncopation, while either staying completely still, or tapping along with the beat. In the following paragraphs I examine what the findings contribute to current understanding of the topic, and the possible reasons for them in relation to each of the three sets of hypotheses of the study.

The first set of hypotheses concerned the **effect of synchronized movement on the participants' affective experience.** I predicted that participants who tapped their feet along to the music would experience higher levels of induced *positive valence* (i.e. pleasure), and higher levels of *tense arousal* (i.e. tension) and *energetic arousal* (i.e. wakefulness), than participants who listened to the stimuli while staying still. None of these hypotheses were supported by the data.

There are number of reasons that might explain these null findings. First, it is possible that the movements of the participants in the tapping condition were so small that they did not produce large-enough effects on the participants' arousal levels, and therefore the spreading of activation predicted by Juslin (2013) and Scherer and Coutihno (2013) did not occur, or it occurred in such a small scale that it did not produce noticeable changes in the participants' subjective feelings. A related explanation is that although motor entrainment did produce a spreading of activation in the participants in the tapping condition, this effect was masked by the difficulty of the synchronization task, as implied by the observed negative correlation between participants' ratings of *difficulty-to-tap-along* with the stimuli, and their ratings of valence and tense arousal. Unfortunately, since this experiment did not take objective measures of the participants' physiological activation levels, it is not possible to empirically examine this conjecture. An important task for future research is to design experimental techniques that allow this type of measures to be taken in a non-intrusive way while the participants are performing bodily movements.

A second explanation of the null results is that the instruments used to measure the participants' affective state (the ambiguous faces technique and the self-report scales) were not sensitive enough to produce significant differences between the groups, particularly because the participants were distributed in a between-subjects design across the two levels of the movement variable. Future studies should use a within-subjects design which would allow the participants to reflect and report any subjective difference between listening to the music while staying still, as compared to their experience while moving along to it.

A third possible way to account for these results is that participants in the tapping condition felt that moving their foot to the beat was a too-restrictive instruction, and that had they made free-movements with any part of their body, the effect of motor entrainment would have been noticeable. Although this is a plausible explanation, it should be noticed that there was no evidence of this in the participants' spontaneous comments, and that a previous experiment which compared participants who stayed still with participants who tapped along or moved freely while listening to groovy music, found that participants preferred listening to the music without moving along in any way (Janata *et al.*, 2012).

Finally, an alternative interpretation of the null results is that perhaps, as predicted by Maes and colleagues (Maes, Dyck, *et al.*, 2014), people's bodily synchronization with music is not driven by the rhythmic qualities of the music, but by its implied expression. Since the stimuli used in this study consisted of drum-breaks with no melodic or harmonic elements, and no variations in micro-timing, then they can be assumed to contain very little, if any, expressiveness. Indeed, several participants in the study spontaneously commented that they found the stimuli to be not "musical enough" –one participant in the tapping condition said: "*to me this isn't actually music, this is just a rhythm, it sounds artificial*". It is therefore possible that moving along with these inexpressive stimuli would not make any difference in the participants' affective state when compared to listening to them while staying still. This possibility is an open empirical question to be explored in future studies, which could compare how listening to stimuli containing only rhythmic information (such as the ones used here), versus stimuli containing carefully manipulated harmonic and melodic elements relates differently to the participants' urges to move and to their affective experience.

It is important to note that explaining the negative findings as caused by a lack of musicality in the stimuli contradicts Witek and colleagues' findings (Witek *et al.*, 2014). They used the same drum-breaks (along with 44 other stimuli), and found that their participants rated the stimuli with intermediate levels of syncopation as eliciting more pleasure than the rest. A possible explanation for this apparent discrepancy is that perhaps when participants in Witek's study answered the question: "*How much pleasure do you experience listening to this rhythm?",* they actually rated their *preference* for some stimuli over others, rather than *induced feelings* of pleasure. With these considerations in mind, future studies on this phenomenon should include measures of perceived musicality of the stimuli, and measures of both preference and induced pleasure, in order to discriminate how these different dimensions of the listeners' experiences interact in the entrainment phenomenon.

The second set of hypotheses concerned the **effect of the degree of syncopation on the participants' affective experience.** Firstly, based on Witek and colleagues' research (Witek *et al.*, 2014), I predicted that stimuli with intermediate degrees of syncopation would be associated with higher ratings of pleasantness, so that the relationship between syncopation and valence could be described as following a negative quadratic trend (i.e. an "inverted U" shape). And secondly, based on Huron's theory (2006), I predicted positive linear relationships between the degree of syncopation of the stimuli and the levels of tense arousal and energetic arousal experienced by the participants.

The first of these three predictions was supported by the data. The ratings from the first of the pair of facial stimuli and from the participants' self-reports of valence show that their levels of pleasure can be better described by a negative quadratic trend than by a linear one. However, these two measures provide conflicting conclusions about the symmetry and width of this inverted curve (i.e. how marked the differences between the different levels of syncopation are): whereas in the results from the facial technique there are significant differences between the low and the medium syncopated levels, in the results from the self-report ratings there are significant differences between the high and low syncopation levels. Future experiments should include a larger number of stimuli in every category, and a larger sample of participants in order to clarify this issue.

The predictions about the effects of syncopation level on participants' ratings of tense arousal and energetic arousal were only confirmed partially: the results suggest that the participants' levels of tension, but not of wakefulness, increased with the level of syncopation of the stimuli. These results confirm the usefulness of distinguishing between these two dimensions of arousal, because they do not correlate highly, they are not experienced as equivalent, and they probably engendered by different physiological processes (Schimmack & Rainer, 2002).

Taken together, this second set of results offers support to Witek's interpretation of Huron's musical expectancy theory (2006), according to which, compared to music with low and high levels of syncopation, music with intermediate levels of syncopation provides an ideal level of predictability about when the next rhythmic event is going to sound, and therefore induces moderate feelings of tension, and a pleasurable urge to move (Witek *et al.*, 2014, p. 8). Furthermore, an analysis of the participants' reports of difficulty while listening to the music supports this interpretation in the stationary group: these participants found it significantly more difficult to stay still while listening to stimuli with intermediate syncopation levels, which were also associated with higher ratings of pleasantness. However, this interpretation does not fit with the data from the participants in the tapping condition, who tended to find it more difficult to tap along with the music as its syncopation level increased, and accordingly, to experience decreasing levels of pleasure. Consequently, Witek's theory seems to be only valid when listening to the music is not accompanied by acting out the urge to move.

A re-interpretation of Colling and Thompson's model of the relationship between music, action and affect (2013) offers a plausible integrative explanation for this disparity. According to this model, listening to music induces *attentional entrainment* (equivalent to *perceptual entrainment* in Trost & Vuilleumier's classification, 2013), a type of neural synchronization made possible by the common coding that underlies perception and action (Hommel, Musseler, Aschersleben, & Prinz, 2001), and the correspondent activation of simulation mechanisms (Molnar-Szakacs & Overy, 2006). This overlap of perception and action systems generates *action plans* which are experienced subjectively as an urge to move along with the music (Chen, Penhune, & Zatorre, 2008). In this model, these action plans work as *expectations* about when the next rhythmic event is going to happen, and are appraised by two feedback loops: a first one in charge of adjusting the accuracy of the predictions, and a second one in charge of producing positive affective experiences when the prediction is correct, or negative ones when the prediction is flawed (as in Huron's theory, 2006). It is possible that in the case of passive listening to groovy music (a case not considered by Colling and Thompson), *perceptual entrainment* generates more intense feelings of pleasure if the music has an intermediate syncopation level, because the action plans work as a virtual fulfilment of the missing rhythmic events. In contrast, if the music has a high syncopation level, almost every action plan is contradicted by the musical input, so the second feedback loop produces mostly negative valence. And if the music has a low syncopation level, the effect of habituation gradually lessens the pleasure feedback provided by this loop.

It can be speculated that this process of synchronization, monitoring and affective feedback is further complicated once the listener enacts the evoked action plans by engaging in motor entrainment. Since perceptual entrainment is a mostly involuntary process, it is probable that the feedback loops are more lenient whenever the predictions are flawed, allowing for a greater degree of imprecision. However, when the listener engages in motor entrainment, the feedback loops have to fine-tune their appraisal function, by comparing the onset of the predicted sound event in the music with the proprioceptive information provided by the moving body. When the onset of these two events tends to mismatch, the first loop produces subjective feelings of difficulty, and the second loop produces subjective feelings of frustration and negative valence, which in the case of this experiment seemed to have been powerful enough to overshadow any possible pleasure derived from mere perceptual (attentional) entrainment.

This interpretation of Colling and Thompson's model, along with the observations about the participants' ratings of difficulty, suggest that rather than the *objective* properties of the rhythm, the factor that better explains people's experiences of pleasure and relaxation with groovy music is their *subjective* motivation and/or difficulty to move with the music, which are in turn modulated by their expertise and familiarity with groovy music. Accordingly, the regression analyses indicated that the more frequently the participants engage in dancing activities the less they experienced pleasure staying still with the music in the stationary condition, and the more they experienced it in the tapping condition; and the more they enjoy groovy musical styles, the tenser they felt while tapping along with the stimuli.

The final set of hypotheses concerned **the interaction effects of movement and syncopation levels**. These predictions were not supported by the data.

6.4.1 Limitations

Some limitations of the study should be noted. First, as mentioned above, a more precise examination of the effects of rhythmic entrainment on listeners' arousal levels implies measuring the participants' patterns of physiological activation, and not just their subjective experience of arousal by means of self-report questionnaires, as in this experiment. While the self-report technique here utilised proved to be informative about the way the two dimensions of experienced arousal (tension, energy) vary independently, it is well known that people's reports of their bodily state do not necessarily correlate with their patterns of physiological change, and depend on individual differences in interoception skills (Barrett, Quigley, Bliss-Moreau, & Aronson, 2004; Wiens, 2005).

The perception-of-ambiguous-faces technique here implemented to indirectly measure the participants' valence does not appear to be reliable in its current form: the scores presented large between-subject variability, their correlation with self-reported pleasantness was small, and the effects of musically induced affect in the perception of this facial stimuli seemed to be quite short-lived: they were only observable in the first pair of the faces that the participants rated, but not in the second. That said, the easiness of the application of the technique (compared to techniques such as Facial EMG), and its relative independence from demand effects, suggest that this could become a practical instrument, whose psychometrical properties should continue to be assessed and improved in future research.

Third, this study did not ask participants to report if they felt any induced feelings of "social bonding", "communion", or "emotional bonding", etc., as predicted by Overy and Molnar-Szakacs (2006) and Juslin (2013b), so this hypothesis is left to be examined in future studies. Nevertheless, it seems unlikely that the solitary context in which this study was carried out would have evoked this type of affective experiences, (previous experiments that have reported affiliation effects of synchronization to music have included at least two people moving in time with the music: e.g. Hove & Risen, 2009; Tarr *et al.*, 2015).

6.5 Conclusion

The results of this study confirm previous findings that listening to music with intermediate syncopation levels evokes pleasant urges to move in time with it. However, the results also suggest that realizing this urge by engaging in motor entrainment does not automatically lead to increased subjective feelings of pleasure, tension, or wakefulness, probably because any positive change in affect associated with the syncopation of the music is outweighed by the perceived difficulty of the synchronization task.

7. The role of embodied simulation and semantic associations in emotional contagion with music

Emotions seem to be contagious: on many occasions we “catch” other people’s emotional states, reacting to their emotions by feeling the same emotional states[24]. In the case of music, the observation that when we perceive a piece as expressive of a particular emotion we frequently feel the same emotion ourselves suggests the possibility that emotional contagion can also occur as a response to musical sounds. Indeed, several scholars have speculated that the same neural and psychological mechanisms underlie both emotional contagion with people and with music (Davies, 2010; Juslin & Västfjäll, 2008; Overy & Molnar-Szakacs, 2009; Schubert, 2013). The two experiments reported in this chapter and the next examine the causal role that one of the proposed mechanisms plays in this type of emotional experience with music, namely *embodied simulation.*

The phenomenon of emotional contagion is well established in contemporary affective science: there is accumulating evidence for our tendency to mimic and share emotions that we perceive in a wide range of stimuli: *facial expressions* (Blairy, Herrera, & Hess, 1999; Hess & Blairy, 2001; Wild, Erb, & Bartels, 2001); *vocalizations* (Hatfield, Hsee, & Costello, 1995; Hawk, Fischer, & Van Kleef, 2012; Neumann & Strack, 2000); and even *films* (de Wied, Zillmann, & Ordman, 1995). Evidence for emotional contagion with music has also been reported in a large number of studies in psychology of music: listeners not only report *perceiving* that music *expresses* emotions, but that music *induces* in them the corresponding emotional feelings – albeit that these induced

---

[24] Admittedly, we sometimes react to other people’s emotional displays with complementary or reciprocal emotions (for example, feeling pity when we learn that someone is sad, or becoming afraid when we see someone’s expressions of anger).

feelings tend to be experienced less intensely than those perceived (Egermann & McAdams, 2013; Evans & Schubert, 2008; Hunter, Schellenberg, & Schimmack, 2010; Kallinen & Ravaja, 2006).

Strictly speaking, emotional contagion with music is paradoxical, because music is not a sentient being capable of feeling emotions (Davies, 2013). However, this paradox is dissolved if we assume that listening to music always involves the experience of perceiving a human agency that produced the sounds (Launay, 2015), and/or if we assume that listening to music somehow "tricks" our brains into perceiving those sounds as resembling the expression of emotions in real human beings (Cochrane, 2010a). Furthermore, both emotional contagion with human expressions and emotional contagion with music have been explained as sharing the same causal mechanism: a type of internal mimicry known as *embodied simulation* (Cochrane, 2010a; Juslin & Västfjäll, 2008; Molnar-Szakacs & Overy, 2006; Scherer & Coutinho, 2013)

7.1 Embodied simulation in social cognition and perception of music

Several theories have converged in the proposal that there is an overlap between the neural and cognitive systems in charge of planning and executing actions, and those in charge of perceiving the actions of others: the mirror neurons theory (Gallese & Sinigaglia, 2011; Iacoboni, 2009), the common coding theory of perception and action (Hommel *et al.*, 2001; W. Prinz, 1997) and embodied theories of cognition (Barsalou, 2008; Glenberg, 2010). These theories also coincide in that the key mechanism that supports action planning, the perception of other people's actions, and mentalizing (understanding other people's mental states) is a kind of internal mimicry known as *embodied simulation*, whereby the perceiver achieves a non-conceptual and direct understanding of the other person's thoughts, feelings and actions by "mirroring or re-enacting their mental states and activities" (Springer, Parkinson, & Prinz, 2013).

Importantly, these theories not only predict that simulation occurs by default, facilitating tasks such as social understanding and emotional contagion, but they also predict that blocking or inhibiting simulation has the opposite effect: for example, Michael *et al.* (Michael *et al.*, 2014) found that using transcranial magnetic stimulation in the participants' hand area of the premotor cortex, resulted in difficulty understanding pantomimed hand gestures.

Drawing upon these theoretical developments, researchers of music cognition have also proposed that perception of music is based on embodied simulation of the motor actions and gestures executed by the musicians who produce the musical sounds (Cox, 2011; Leman & Maes, 2015; Overy & Molnar-Szakacs, 2009, Colling & Thompson, 2013). Several recent studies have found evidence that supports this claim. For example, Leman *et al.* (2009) found that listeners' arm movements while listening to music played on the *guqin* (a traditional Chinese plucked-strings instrument) matched the patterns of movements of the performers' shoulders. Neuro-imagining studies have found activation of brain areas associated with perception of music and areas associated with producing vocalizations and with motor planning: namely the supplementary motor area, mid-premotor cortex, and cerebellum (Brown & Martinez, 2007; Callan *et al.*, 2006; Chen *et al.*, 2008). And Novembre and colleagues (Novembre, Ticini, Schütz-Bosbach, & Keller, 2014) have recently provided evidence of motor simulation in musicians: in their study, pianists either practiced or not the left-hand part of several musical pieces. Subsequently, they received transcranial magnetic stimulation (TMS), which inhibited their left-hand motor areas, and were asked to play the *right hand* part while simultaneously listening to the left-hand part. The researchers found that the TMS had a disruptive effect on the pianists' performance only when they played pieces in which they had practiced the left-hand part before. This suggests that even when they were playing only the right hand part, their brains were inevitably *simulating* the movements of the left hand part in these previously practiced pieces.

7.1.1 Embodied Simulation in Affective Phenomena

The theories reviewed so far claim that action perception, social cognition, and music perception can be explained in terms of embodied simulation. But does this mechanism underlie emotional phenomena as well? Two lines of research suggest that this is the case: both Niedenthal and colleagues (Niedenthal *et al.*, 2005; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009) and Barrett and colleagues (Barrett, 2006b; Wilson-Mendenhall *et al.*, 2011) have proposed that embodied simulations are activated not only when people respond to present emotional stimuli (e.g. Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001), but also when they *think* about emotional concepts and symbols (e.g. Oosterwijk, Rotteveel, Fischer, & Hess, 2009).

It is important to note that, in spite of the growing supporting evidence for the role of embodied simulation in emotional processes (Glenberg, 2010; Niedenthal *et al.*, 2005; Winkielman *et al.*, 2015), the majority of research so far has suggested that adopting or mimicking emotional postures, gestures, vocalizations, etc. *modulates*, rather than completely changes the emotional state of participants. Thus, studies on mimicry and emotional contagion have demonstrated that being exposed to and/or mimicking a positive or negative stimulus (e.g. an expression of fear, anger, disgust, joy, etc.) leads to changes in participants' ratings of induced *affect*, that is, to changes in experienced valence in the *same direction* as the valence of the stimulus, but not to the induction of the *same discrete emotion* as the one observed (Flack, 2006; Hatfield *et al.*, 1995; Hess & Blairy, 2001; Mcintosh, 2006; Neumann & Strack, 2000). Indeed, in all these studies the participants' ratings of induced emotion showed a "bleeding effect", that is, when a participant reported feeling a negative emotion (e.g. disgust) they also reported feeling other negative ones simultaneously (e.g. anger and fear). To my knowledge, so far only one study (Hawk *et al.*, 2012) has found that *hearing* emotional vocalizations of discrete emotions leads to both mimicry and *induction* of the corresponding discrete emotions in the participants. Taken together, these findings cast doubt on the notion that engaging in behaviours that facilitate embodied simulation can *by itself* lead to the induction of discrete emotions.

7.1.2 Embodied Simulation in Musical Emotions

If perception of others' actions and emotions, perception of music, and even elicitation of emotions are based upon embodied simulation, then it follows that musical emotions can also be explained in these terms. Indeed, several theorists in Philosophy and Psychology of Music (Cochrane, 2010a; Davies, 2013; Jackendoff & Lerdahl, 2006; Juslin & Västfjäll, 2008; Molnar-Szakacs & Overy, 2006; Scherer & Coutinho, 2013) have concurred with the proposal that: a) some features of musical sounds resemble the expression of emotions (or even the proprioceptive feelings) in the voice and the body (cf. Coutinho & Dibben, 2012; Juslin & Laukka, 2003); and b) perceiving those expressive musical features elicits internal mimicry, which in turns, leads to emotional contagion with the emotion expressed by the musical piece.

Psychological theories differ in regards to the aspect of music proposed to elicit simulation, and therefore, in the type of internal mimicry they implicate. For Juslin and colleagues (Juslin, 2013b; Juslin et al., 2010; Juslin & Västfjäll, 2008) the *melodic* aspect of music can elicit internal mimicry when particular instrumental timbres (such as the violin or the cello) are heard as "super-expressive voices" resembling the expression of basic emotions in vocalizations (Juslin & Laukka, 2003, p. 803). This resemblance activates subvocalization processes supported by mirror-neuron brain systems, leading to the induction of the corresponding basic emotions in the listener. In contrast, Scherer and colleagues (Scherer & Coutinho, 2013; Scherer & Zentner, 2001), emphasise the observation or imagination of *motor expressions* of the (implied) performing musicians as the stimuli that elicit muscular and neural mimicry, and subsequently, emotional contagion.

It is plausible that these two theories are not mutually exclusive, and that both types of simulation operation simultaneously facilitating emotional contagion with music. Whereas simulation via subvocalization may be responsible for the perception of emotional qualities associated with variations in timbre, pitch, and melodic contour (i.e. prosody), simulation of motor gestures may be responsible for the perception of emotional qualities associated with bodily movements, like strength, speed, and energy. Indeed, Overy and Molnar-Szakacs' SAME model of affective experience (Molnar-Szakacs & Overy, 2006; Overy & Molnar-Szakacs, 2009) predicts that both mimicry of physical gestures and vocal mimicry can be simultaneously activated by music listening, and play a central role in the perception and induction of musical emotions.

To my knowledge, no empirical research has attempted to test the hypotheses that derive from these theories. However, four lines of research have provided evidence that suggests the involvement of embodied simulation mechanisms in emotional experiences with music.

First, a neuroimaging study led by Koelsch (Koelsch *et al.*, 2006) found that listening to pleasant pieces of music (compared to dissonant, unpleasant versions of the same pieces) activated brain areas associated with the formation of premotor representations of vocal sound production (Rolandic operculum, anterior superior insula, and ventral striatum).

Second, a variety of studies have found that listening to music can elicit a pleasant motivation to mimic some aspect of it, suggesting that embodied simulation can be simultaneously a cause and a consequence of emotional engagement with music. For example, it has been shown that rhythmic music elicits a pleasurable urge to move in time with the sounds (Janata *et al.*, 2012; Labbé & Grandjean, 2014; Witek *et al.*, 2014) that singing along is a very common response to listening to favourite music (DeNora, 2000; Dibben & Williamson, 2007), and that audio-visual presentations of emotional singing elicits facial mimicry in observers (Chan, Livingstone, & Russo, 2013).

Third, a couple of studies have suggested that people's movements while listening to music affect their preferences and their perception of emotions expressed by that music. Sedlmeir et and colleagues (2011) found that asking participants to make positively or negatively-associated facial, head, or arm movements while listening to a piece of music (i.e. smiling, nodding or flexing the arms vs. not-smiling, head-shaking or extending the arms), had systematic effects on their preferences: those participants who made positive-associated movements reported enjoying the music more than participants who made negative ones. Similarly, Maes and colleagues (2013) asked two groups of children to learn either a "sad" or a "happy" dance choreography to an ambiguous piece of music, and found in a later test, that the type of choreography the children learned biased their perception of the emotion expressed by the music.

Finally, two experiments on cross-modal perception of emotions found parallels between perception of emotions in music and in movement. In the first one, conducted by Sievers and colleagues (Sievers, Polansky, Casey, & Wheatley, 2012) the researchers asked participants from two different cultural backgrounds to manipulate several parameters in a computer program in order to make either a piece of music, or a virtual ball, sound or move in an emotionally expressive way. They found that in both cultural groups, the participants used an equivalent set of features to make the virtual ball and the musical piece represent the same target emotions. The second experiment, carried out by Giordano and colleagues (Giordano, Egermann, & Bresin, 2014), compared the use of expressive sound features in music and in walking, and found that the sound features that people use to express and perceive emotions in walking sounds coincided with the musical features used to express emotions in music (as reported by Juslin & Laukka, 2003).

7.1.3 Is Embodied Simulation Mediated by Other Factors?

As mentioned above, research has found that manipulating people's facial, vocal or bodily expressions can *bias* their emotional state, but it cannot by itself lead to the induction of discrete, full-blown emotions. In consequence, it is also unlikely that any type of mimicry (either behavioural or implicit) by itself can lead to the induction of emotional contagion without the influence of other factors, such as the context, or the present goals of the individual. Indeed, constructionist approaches to emotion such as Russell's Core Affect model (2003) and Barrett's Conceptual Act Theory (Barrett, 2006b) have emphasized that contextual information, and the accessibility of linguistic categories are critically involved in the perception of emotions (Barrett, Lindquist, *et al.*, 2007; Barrett, Mesquita, Gendron, & Kensinger, 2010; Carroll & Russell, 1996) and in the elicitation of emotional episodes (Fugate & Barrett, 2014; Lindquist & Barrett, 2008; Wilson-Mendenhall, Barrett, & Barsalou, 2013). Furthermore, research reviewed by Hess and Fischer (2013) and by Carr & Winkelman (2014) indicates that mimicry is flexible and mediated by factors such as social affiliation: for example, participants are more likely to mimic other people's expressions if the person making the gestures is perceived by the observer as cooperative, and as belonging to the same social group.

Regarding emotional contagion with music, two of the most influential contemporary theories, the BRECVEMA (Juslin, 2013b), and the Multifactorial Process Model (Scherer & Coutinho, 2013) propose that emotional responses to music emerge from the interaction of multiple psychological mechanisms which are activated by contextual, personal, and musical factors. Thus, in any instance of emotional contagion with music, it is unlikely that embodied simulation be the *only* mechanism responsible for a listener's emotional reaction to a piece of music. In the BRECVEMA theory (Juslin, 2013b), the mechanism that most clearly reflects the listener's encoding of the context where the music takes place, is *visual imagery*; a mechanism whereby the listener reacts emotionally to the images that he or she visualises while listening to the music.

7.2 Overview of the present study

The previous review demonstrates that although there is accumulating evidence that embodied simulation is causally involved in both emotional processing and in music perception, we do not have yet evidence that embodied simulation plays a causal role in the phenomenon of emotional contagion with music, nor of the extent to which this mechanism might be mediated by other factors.

The first aim of the two experiments that constitute this study (reported in this chapter and the next) is to respond to this gap in knowledge by testing the role of embodied simulation in emotional contagion with music. Specifically, I compared two competing hypotheses derived from the theories reviewed above: the BRECVEMA theory (Juslin, 2013b), which claims that implicit mimicry of the melodic aspects of the musical material leads to emotional contagion, and the Multifactorial Process Model (Scherer & Coutinho, 2013), which claims that implicit mimicry of the musician's gestures when producing the music drives the contagion response.

The second aim of this study is to examine the extent to which emotional contagion with music is mediated by other factors such as the activation of mental imagery and the activation of semantic information and personal associations. Additionally, the second experiment also explored the possibility that considerations of social affiliation and empathic attitudes worked as important mediators in this phenomenon.

7.3 Experiment 1

Since embodied simulation can be facilitated or hampered by engaging in behavioural activities associated with the respective neural resources, I asked participants to listen to music and to perform behavioural tasks which either facilitated or prevented simulation. Thus, two groups of participants performed simulation-facilitating tasks: one group was instructed to mimic the music's *melody* (i.e. to sing along with the piece), and another to mimic the *gestures* necessary to produce the music (i.e. to pretend to play the instruments doing "air-playing"). A third group of participants performed a simulation-hampering task: they were instructed to use their arms and their voice in a mildly distracting task while the music played. Finally, a fourth group of participants was recruited in order to examine the effect of embodied simulation when it is neither facilitated nor blocked (i.e. they constituted a control condition): they were instructed to remain completely quiet and still while the music played.

The hypotheses of the experiment were as follows. I predicted that participants in the two simulation groups (vocal, motoric) would experience more intense perceived and induced emotions while listening to the music in comparison to the other groups (**Hypothesis 1A**), that the participants in the distracting task group would experience the least intense perceived and induced emotions (**Hypothesis 1B**); and that the scores of perceived and induced emotions of the participants in the control group would fall between the scores of the two simulation groups and the distracting group (**Hypothesis 1C**). Additionally, since past research on embodied simulation has found that expertise in a given task facilitates simulation (Beilock & Holt, 2007; Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005), I predicted that participants who can play a musical instrument present in the music would experience more intense perceived and induced emotions than those who cannot (**Hypothesis 1D**).

The role of personal associations and visual imagery in emotional contagion was examined by using pieces of music that could be simultaneously perceived as expressive of different emotions (e.g. as expressive of sadness or tenderness), and by asking the participants to report what they thought while listening to each piece. Based on Juslin's theory about the role of visual imagery in the induction of musical emotions (Juslin, 2013b), I predicted that there would be a correspondence between the content of the participants' imagery and their ratings of perceived and induced emotions (**Hypothesis 2**).

Table 7.1 *Summary of hypotheses*

Effect of Simulation	Hypothesis 1A	Participants in the Motor Simulation and Vocal Simulation groups will experience more intense induced and perceived emotions than participants in the Control and Distracting Task groups.
	Hypothesis 1B	Participants in the Distracting Task group will experience the least intense perceived and induced emotions compared to the other groups.
	Hypothesis 1C	Scores of perceived and induced emotions in the Control group would fall between the scores of the Simulation groups and the Distracting Task group.
	Hypothesis 1D	There will be a positive and significant correlation between scores of being-able-to-play-an-instrument-present-in-the-piece, and scores of most intensely perceived and induced affects.
Effect of visual Imagery	Hypothesis 2	The content of the participants' narratives about what they imagined while listening to the pieces will have the same emotional content as the emotions they reported in the questionnaires about perceived and induced emotions.

7.4 Method

7.4.1 Participants

A total of 127 participants aged between 19 and 66 (Mean = 29.9, SD = 9.5, 79 Women) took part in the experiment. They were recruited on a voluntary basis from the city and the University of Sheffield, UK. Three participants were excluded from the analysis because they did not follow the instructions correctly. All the instructions and questionnaires were in English, which was the first language for 59.7% of the participants; however, those participants for whom English is a second language were all students at the University of Sheffield.

The participants' musicality was measured by using two scales from the Goldsmith's Musical Sophistication Index [Gold-MSI] (Müllensiefen *et al.*, 2013). Their scores in the *Musical Training* scale had a mean of 25.74 (SD = 6.65). Their level of *Musical Engagement*, had a mean of 38.7 (SD = 8.18). These scores suggest that overall, the participants had a similar mean level of musicianship to the sample used to develop this instrument ($M_{training}$ = 26.52, SD = 11.44; $M_{engagement}$ =41.52, SD = 10.36), as documented by Müllensiefen *et al.* (Müllensiefen *et al.*, 2013).

Given the objectives and the procedure of this experiment I asked the participants to report how often they sing along when they listen to music, and how often they pretend to play the instruments they hear when they listen to music. Their mean scores for the first question were of 3.66 (SD = 0.92) and for the second of 2.13 (SD = 1.35).

Participants were randomly assigned to four experimental conditions (31 per condition): vocal simulation, motor simulation, distracting task, and control task.

7.4.2 Design

The experiment used a between-subjects design, with *Type of simulation* as the between-subjects independent variable (four levels: *Vocal Simulation*, *Motor Simulation, Distracting Task, Stationary*); and *Perceived* and *Induced affective states* as dependent variables.

7.4.3 Stimuli

The musical stimuli consisted of three instrumental pieces identified from the Movie Soundtrack Database developed at the University of Jyväskylä (Eerola & Vuoskoski, 2011), and chosen because they could be perceived as moderately expressive of emotions[25] in the four quadrants of Two-Dimensional Affective Space (Russell & Barrett, 1999). Since I used longer versions of the pieces than those found in the Database, I pre-tested their ability to express the target emotions in a pilot study with 28 participants who did not take part in the main experiment.

- "Kip's lights" from the movie *The English Patient* (1997). This piece is perceived as expressive of **sadness** or **tenderness**. The piece consists of a piano playing a slow, right-hand melody accompanied by a small ensemble of strings, clarinet and celesta. Major mode. Tempo = 60 BPM. The stimulus can be listened to on: https://soundcloud.com/julian-cespedes-guevara/1a-2/s-Z7aG5

- "Max" From the movie *Cape Fear* (1991). Perceived as expressive of **fear** or **anger**. The piece starts with the brass playing two loud semibreve notes with a 7th major interval. After a quiet moment played by the strings, the brass instruments play loud descending phrases, including a tri-tone interval (Bb to E). These phrases are then answered by the strings playing descending chromatic scales with fast tremolo. Minor mode. Tempo = 60 BPM. The stimulus can be listened to on:

  https://soundcloud.com/julian-cespedes-guevara/22a/s-1BLdK

- "Oliver learns the hard way" from the movie *Oliver Twist* (2005). Perceived as expressive of **joy** or **excitement**. The piece is characterised by a solo clarinet repeatedly playing a simple, *cantabile* melody accompanied by small ensemble of strings playing a syncopated rhythm. A percussion instrument (probably an Irish bodhran) plays a small roll at the end of each phrase from the clarinet. Minor mode. Tempo = 120. The stimulus can be listened to on:

  https://soundcloud.com/julian-cespedes-guevara/3a-2/s-7yyPx

In the main experiment each participant listened to the pieces twice in a row, so that the participants in the simulation conditions had a chance to become familiarized with

---

[25] I chose moderately expressive pieces rather than pieces with the highest scores in order to prevent having a ceiling effect, which would make the effects of the independent variable unobservable.

how the music unfolded. The pieces were edited together with no silence between start and end, and therefore the stimuli had a mean duration of 137.33 seconds (SD = 8, 02).

7.4.5 Measures

The participants' affective experience was measured with a combination of direct and indirect techniques. First, their *induced affective state* was measured by using an indirect technique developed by Niedenthal and colleagues (2000)in which participants are asked to control a computerised movie displaying a facial expression which changes from an initial positive expression into a negative one, and to detect the offset of the initial expression (See Figure 7.1). Participants were told that they could control the movie with the arrows of a keyboard to go forward and backwards as many times as they wanted, and to stop it at the point in which they perceived that, "for the first time, the face no longer expressed its initial emotion" (Niedenthal *et al.*, 2000, p. 857). The experimenter then registered the frame number (out of 100) in which the participant decided to stop the movie. (The frame numbers were hidden from the participants). It was expected that participants in positive affective states would see the offset of the happy expression at an earlier point than participants in negative affective states.

The second measure of participants' induced affective state was a 15-items ad-hoc questionnaire developed by the experimenter to test the possibility that emotional states induced by music may elicit subjective feelings similar to regular, everyday emotions (Frijda *et al.*, 1989). Unlike other existing questionnaires this one captures action tendencies – an important but often-overlooked component of emotion in music studies-, physical sensations, and appraisals. (See Table 7.2 for the complete list of items).

The third measure of induced affect was a 14-items questionnaire including core affect adjectives (i.e. valence, tense arousal, and energetic arousal), discrete emotional adjectives taken from the GEMS-25 (Zentner et al., 2008) and items from a questionnaire used by Juslin and colleagues in a recent experiment on induction of musical emotions (Juslin *et al.*, 2013). Importantly, taking in consideration that folk emotional concepts are probably organized as fuzzy sets rather than as clearly defined categories (Russell & Fehr, 1994; Scherer, 2005), each item of the questionnaire included two or three adjectives related to the same emotional category (for example: anxious/scared; sad/sorrowful; happy/cheerful).

The participants' *perception of emotions expressed by the music* was measured by using a 15-items questionnaire containing pair of adjectives corresponding to the same categories as the ones used in the induced emotions questionnaire. (For example, the item "fear, dread" in this questionnaire corresponded to the item "anxious, scared" in the induced emotions questionnaire). (Table 7.2 presents the items of the three questionnaires).

The participants were also asked to report how much they *liked* the piece they listened to, and how *familiar* they were with it; how *difficult* they found the task that was assigned to them while listening to the music, and how *embarrassing* they found performing the task. (For the participants in the Stationary condition, this question was changed to report whether they felt uncomfortable with the presence of the experiment behind them while doing the experiment).

Due to the potential mediating role of empathic attitudes in emotional contagion with music (Egermann & McAdams, 2013; Vuoskoski *et al.*, 2012), the participants' *Trait Empathy* was measured with the Interpersonal Reactivity Index (Davis, 1983), which evaluates four facets of empathy: *Fantasy*, *Empathic Concern Personal Distress*, and *Perspective Taking*.

The participants' thoughts while listening to the music were explored with a short interview at the end of the experiment. Additional measures consisted of a questionnaire of demographic information, the *Engagement* and *Musical Training* scales from the *Goldsmith's Musical Sophistication Index* [Gold-MSI] (Müllensiefen *et al.* 2013), and a question asking the participants to report which, if any, musical instruments they can play.

Table 7.2 *Items in the self-report questionnaires*

Induced affective states	Perceived affective states	Subjective Feelings and Action Tendencies
Pleasant, well	Positive feelings	Like I wanted to listen more, to make the experience longer
Unpleasant, Bad	Negative feelings	Like I didn't want to have anything to do with the situation, like staying away from it
Tense, Jittery	Tension, unease	Like I wanted to understand or learn more about the situation
Relaxed, At ease	Peacefulness, serenity	Like things going on did not involve me, like not paying attention to them
Awake, Energized	Alertness, Readiness	Like crying
Sleepy, Drowsy	Tiredness, Weariness	Like a need to be comforted, like needing a hug
Mellowed, Softened-up, Affectionate	Tenderness, Love	Like I wanted to attack something
Sad, Sorrowful	Melancholy, Misery	Like I was boiling inside
Nostalgic, Longing	Longing, Reminiscence	Like I was in command of the situation
Happy, Cheerful	Joy, Amusement	like I needed to protect myself, Like hiding away
Anxious, Scared	Fear, Dread	Like I was paralyzed, frozen
Triumphant, Strong	Pride, Power	Like I could not concentrate or order my thoughts
Irritated, Frustrated	Anger, Irritation	Like jumping around
Inspired, with feelings of Transcendence, of Spirituality	Spirituality, Otherworldliness	Like laughing
Uninterested, Indifferent	Boredom, Apathy	Like everything was fine
Soothed, Serene		
Filled with Admiration, with Wonder, Awed, Overwhelmed		

Figure 7.1 Example of the facial stimuli used in the indirect measure of affect. The photos show the process of morphing of the facial expression from the first frame (leftmost photo), at the 25th frame, at the 50th frame, at the 75th frame, and at the last frame (100th).

7.4.6 Procedure

Participants were tested individually in one session. When they arrived at the laboratory they were informed that the experiment concerned the psychological effects of listening to short instrumental pieces of music, and they were seated in a comfortable chair in front of a desk with two computers; one was used to show the instructions and questionnaires, and one to display the movies from the indirect measurement technique. Additionally, the participants in the Distracting Task condition found a box with colour cubes on the desk, and two other boxes located at arm's length: one on the right side, over the desk, and one on the left side, on the floor (See bottom left panel in figure 7.2). The experimenter was present during the whole procedure, sitting at another desk behind the participants.

After reading and signing the consent forms, a message on the main screen informed the participants that during the experiment they would listen to three short instrumental pieces of music, while doing something else at the same time, and that after each piece, they would do a simple "visual task" (i.e. the indirect measurement), and then answer some questionnaires. Then they read the instructions to do the indirect measurement of affect:

> The computer screen on your left will display the photo of a person who gradually changes from one emotion to another. Please use the right and left keys in the keyboard to see how the expression in the face changes. Stop at the first moment in which you perceive that the face no longer expresses the initial emotion.

Once the participants had satisfactorily practiced this task, the main computer screen displayed the instructions of their corresponding experimental condition. After being notified that they would listen to the piece of music twice, and that they had to try to "identify the message that it conveys", they received the following instructions (See figure 7.2):

- *For the participants in the* Vocal Simulation *condition: "*While you listen, please SING or HUM along to the melody while the music unfolds. It does not matter if you shift your attention from one instrument to another while singing. It is not important whether you can sing in tune or not, the experimenter will not be measuring or judging your singing. However, it is crucial that you sing sufficiently loud that the experimenter can hear you."
- *For the participants in the* Motor Simulation group *condition: "*While you listen, please PRETEND YOU ARE PLAYING THE INSTRUMENTS THAT YOU HEAR and make the movements you think the musicians would make while playing. It does not matter if you switch from one instrument to another along the way. It is not important if you know how to play these instruments or can pretend to play them accurately. The experimenter will not be measuring or judging your

pretend-playing. However, it is crucial that your movements are sufficiently large so that the experimenter can see you making them."

- *For the participants in the* Distracting Task *condition:* "While you listen, please MOVE THE CUBES from the box in front of you to the other boxes, one at a time. Put the blue ones in the box to your left, and all the others in the box to your right. COUNT OUT LOUD each cube that you move."
- *For the participants in the control condition:* While you listen, please stay completely still and silent. You do not have to be tense, but it is important that you do not things like humming the melody, tapping your feet, or swaying your body to the rhythm of the music."

All the participants practiced the corresponding task while listening twice to a fragment of Satie's Gymnopedie No.1 (total duration = 82 seconds). After taking base-line measures of affect with the indirect technique and a short questionnaire, the participants followed the same procedure for each trial: listening to a piece of music twice while performing the experimental task, completing the indirect measurement technique, and filling the self-report questionnaires of induced and perceived affective states. The musical stimuli were presented in a counterbalanced order through headphones (Bose AE2), adjusted at a comfortable sound level.

Once the participants finished the third trial, the experimenter asked them to listen to a fragment of each stimulus once more, and to tell him "*what when through their minds*" while they listened to them in the experiment. After this, they filled the questionnaires about demographic information, musicality and trait empathy. The experiment ended by debriefing the participants, and by offering them a chocolate bar as a reward for their participation. The whole procedure took 50 minutes on average.

Figure 7.2 Enactment of the Motor Simulation and Distracting Task conditions. The panels above represent the typical gestures made by participants while listening to the music in the Motor Simulation condition. The panel on the bottom left corner shows the setting that participants in the Distracting Task found: notice the box with cubes in the middle, and the two boxes at the right and left of the computer. The middle and bottom right panels represent the way participants allocated the cubes in the boxes while counting out loud and listening to the music.

7.5 Results

The results section is organized as follows:

1) The analysis of the validity of the two novel measures of affect: the perception of morphing faces task, and the questionnaire of subjective feelings and action tendencies.
2) The manipulation check, i.e. an evaluation of the extent to which the three pieces communicated and elicited the target emotions.
3) The results of the test of hypotheses.
4) The analyses of the role of covariates in the results.
5) The analysis of the qualitative data gathered from the question: “what went through your mind while listening to the music?”

7.5.1 Validity of Perception of Morphing Faces Technique

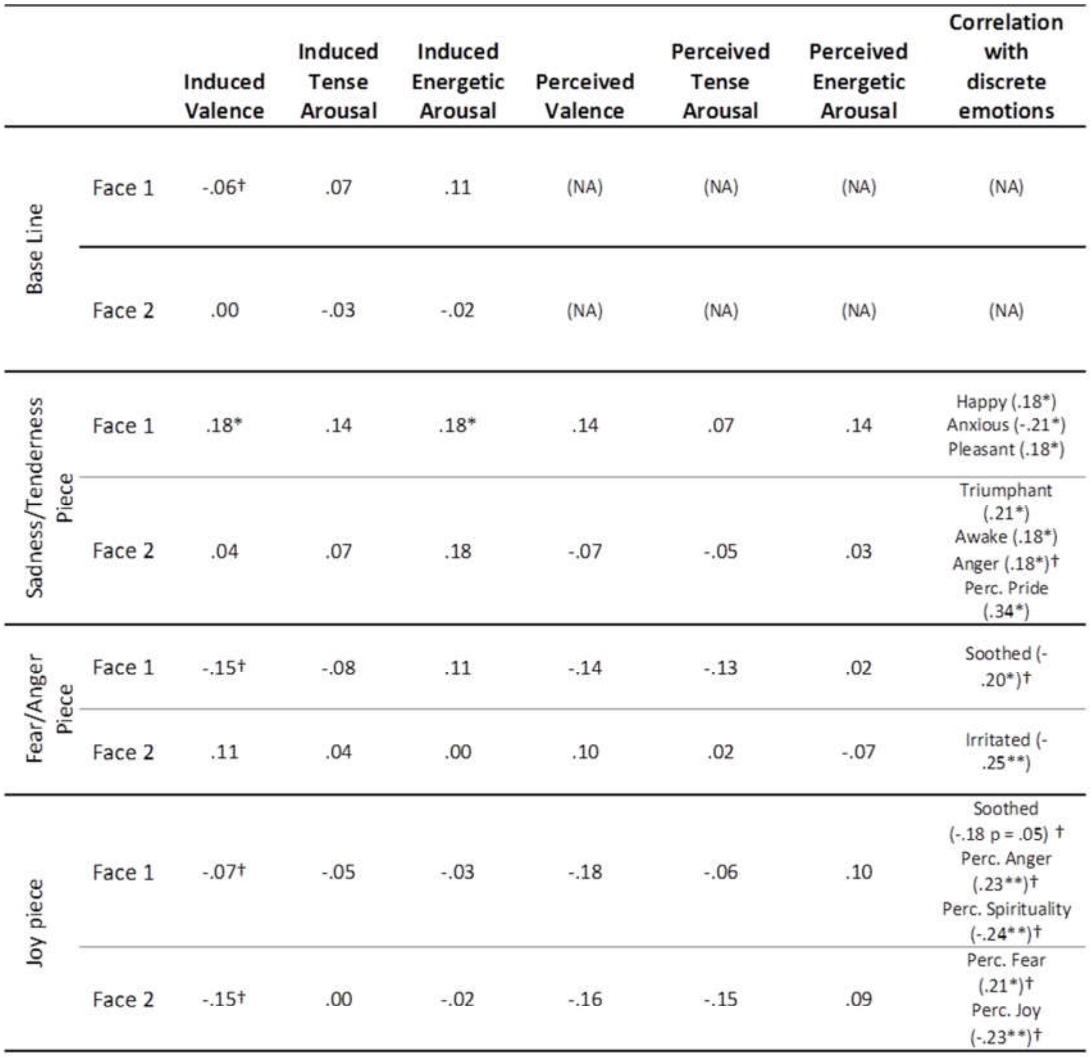
As an indirect measure of induced valence, after each trial the participants performed a task consisting of seeing a pair faces in succession, each of which “morphed” from a positive to a negative emotional expression, and to detect the first point at which each face no longer expressed the initial emotion. Based on Niedenthal and colleagues’ findings using this technique (Niedenthal *et al.*, 2001, 2000), it was expected that participants who were in a positive affective state would perceive the change earlier than those who were feeling unwell. The score was registered as the frame number which the participant chose as the inflexion point. There were 100 frames in each morphing video, therefore this scale ranged from 1 to 100.

Since I observed a lot of variability in the use of the scale between participants (some chose to see the whole range of change in the morphing face before making their decision, whereas others made their decision based on their first impression), I transformed the scores into z-scores. A positive z-score indicates that the participant tended to feel more negative valence, and a negative z-score indicates that the participant tended to feel more positive valence.

The correlations between these z-scores and the ratings from the questionnaires of induced and perceived affect are not compatible with the prediction. Only the data from the second face after listening to the Joy piece show the expected correlations: the scores of self-reported positive affective states correlate negatively with the morphing face scores, and the self-reported negative states show correlate positively with the morphing face scores. However, not all the observed correlations are statistically significant, and none of them is higher than .28 (mean correlation coefficient = 20.88). (See Table 7.3 for a summary of these correlation analyses).

How to interpret these results? While it is possible that these low and non-existent correlations between the scores of the morphing faces technique and the self-report questionnaires may be due to the participants having reported higher levels of affective involvement in the questionnaires than they actually felt, a more conservative explanation is that the high variability in the way the participants approached the morphing faces task, and other individual differences in perception of emotions in facial expressions produced the observed results. In conclusion, in the context of this experiment, the morphing face technique cannot be assumed to be a reliable measurement of the participants' affective state, and therefore, I do not include this data in the subsequent analyses.

Table 7.3 *Correlation between z-scores from indirect technique and scores from self-reports of induced and perceived core affect and discrete emotions*



		Induced Valence	Induced Tense Arousal	Induced Energetic Arousal	Perceived Valence	Perceived Tense Arousal	Perceived Energetic Arousal	Correlation with discrete emotions
Base Line	Face 1	-.06†	.07	.11	(NA)	(NA)	(NA)	(NA)
	Face 2	.00	-.03	-.02	(NA)	(NA)	(NA)	(NA)
Sadness/Tenderness Piece	Face 1	.18*	.14	.18*	.14	.07	.14	Happy (.18*) Anxious (-.21*) Pleasant (.18*)
	Face 2	.04	.07	.18	-.07	-.05	.03	Triumphant (.21*) Awake (.18*) Anger (.18*)† Perc. Pride (.34*)
Fear/Anger Piece	Face 1	-.15†	-.08	.11	-.14	-.13	.02	Soothed (-.20*)†
	Face 2	.11	.04	.00	.10	.02	-.07	Irritated (-.25**)
Joy piece	Face 1	-.07†	-.05	-.03	-.18	-.06	.10	Soothed (-.18 p = .05) † Perc. Anger (.23**)† Perc. Spirituality (-.24**)†
	Face 2	-.15†	.00	-.02	-.16	-.15	.09	Perc. Fear (.21*)† Perc. Joy (-.23**)†

N= 124

Correlation statistic: Spearman's Rho

* = $p < 0.05$ level, ** = $p < .001$ (2-tailed).

† = Observed correlations in the predicted direction.

7.5.2 Validity of the Subjective Feelings and Action Tendencies questionnaire

This novel questionnaire was intended to constitute an additional technique to measure the extent to which the participants felt emotionally "moved" by the music, by exploring their experienced subjective feelings, physical sensations, and appraisals.

7.5.2.1 Correlations between subjective feelings and induced emotions

The correlation analysis between participants' ratings in the *Subjective Feelings & Action Tendencies* questionnaire and their ratings in the *Induced Emotions* questionnaire reveals that the two questionnaires show a coherent pattern of correlation. For example, in all of the pieces, there are moderate to high positive correlations (Rho > .21, < .54) between scores of *Needing-to-be-comforted* and scores of *Induced Sadness*; between scores of *Feeling-in-command-of-the-situation* and scores of *Induced Happiness* and *Induced Triumph*; and of *Wanting-to-attack-something* and scores of *Induced irritation.*

Nevertheless, it is important to note that in most cases, the results of the *Subjective Feelings & Action Tendencies* questionnaire do not point to single, discrete emotions. On the contrary, several of these subjective sensations and action readiness states were associated with several discrete emotions, which importantly, have the same valence. For example, scores of *Wanting-to-attack-something* correlate positively with scores of *Induced Sadness*, *Induced Anxiety* and *Induced Irritation,* and negatively with scores of feeling *Mellowed* and of feeling *Soothed*; and scores of *Wanting-to-dance* correlate with *Induced Happiness*, *Induced Triumph*, and *Induced Transcendence;* and negatively with *Induced Irritation.* (Table 7.4 displays the results of the correlation analyses).

In sum, these results suggest that the *Subjective Feelings & Action Tendencies* questionnaire worked as a valid measure of how emotionally moved the participants felt, and therefore, I include it in the hypothesis testing analyses.

Table 7.4 *Significant correlations between scores from the Subjective Feelings & Action Tendencies Questionnaire and scores from the Discrete Induced Emotions questionnaire*

	Sad/Tender Piece		Fear/Anger piece		Joy Piece	
Needing to be comforted	Sad	.41**	Sad	.22*	Nostalgic	.21*
	Nostalgic	.35**	Happy	-.18*	Admiring	.30**
	Anxious	.23*	Irritated	.26**	Transcendent	.21*
	Transcendent	.21*				
Wanting to dance	Soothed	.02*	Mellowed	.23*	Soothed	.29*
	Happy	.03*	Soothed	.25*	Nostalgic	.22*
	Admiring	.02*	Happy	.25*	Happy	.41*
	Transcendent	.03*	Triumphant	.29*	Triumphant	.42*
	Irritated	-.09*	Transcendent	.18*	Transcendent	.32*
	Uninterested	-.03*				
Feeling like everything is fine	Mellowed	.31*	Mellowed	.26*	Mellowed	.24*
	Sad	-.40**	Sad	-.19*	Soothed	.47**
	Soothed	.59**	Happy	.45*	Happy	.64**
	Happy	.61*	Anxious	-.50**	Anxious	-.29*
	Anxious	-.32*	Triumphant	.34**	Triumphant	.32**
	Admiring	.03*	Irritated	-.26*	Admiring	.46**
	Transcendent	.33**			Transcendent	.32*
	Irritated	-.23*			Irritated	-.28*
	Uninterested	-.30*				
Not being able to concentrate	Mellowed	-.21*	Mellowed	-.24*	Nostalgic	.19*
	Triumphant	-.04*	Sad	.33**	Uninterested	.24*
	Transcendent	-.25*	Anxious	.40**		
	Irritated	.28*	Irritated	.37**		
	Uninterested	.20*	Uninterested	.33**		
Wanting to understand more	Nostalgic	.31*	Sad	.19*	Soothed	.22*
	Happy	.22*	Soothed	.24*	Nostalgic	.33*
	Triumphant	.25*	Triumphant	.27*	Triumphant	.39*
	Admiring	.27*	Admiring	.23*	Admiring	.40**
	Transcendent	.27*	Transcendent	.25*	Transcendent	.26*
	Uninterested	-.27*			Uninterested	-.20*
Feeling like things do not involve me	Mellowed	-.21*	Mellowed	-.04*	Happy	-.24*
	Soothed	-.20*	Sad	.21*	Triumphant	-.19*
	Nostalgic	-.26*	Nostalgic	.21*	Uninterested	.30*
	Triumphant	.19*	Irritated	.24*		
	Irritated	.28*	Uninterested	.27*		
	Uninterested	.25*				
Wanting to avoid the situation	Mellowed	-.35**	Mellowed	-.22*	None	
	Sad	.22*	Happy	-.30*		
	Soothed	-.34*	Anxious	.41**		
	Happy	-.22*	Triumphant	-.25**		
	Anxious	.23*	Irritated	-.34**		
	Admiring	-.31	Uninterested	-.21*		
	Irritated	.34**				
	Uninterested	.30*				
Wanting to hide	Mellowed	-.19*	Mellowed	-.20*	Happy	-.23*
	Sad	.27*	Sad	.26*	Anxious	.42**
	Soothed	-.31*	Happy	-.42**	Irritated	.23*
	Happy	-.31*	Anxious	.66**		
	Anxious	.31*	Irritated	.30*		

Table 7.4 (continued) *Significant correlations between scores from the Subjective Feelings & Action Tendencies Questionnaires and scores from the Discrete Induced Emotions Questionnaire*

	Sad/Tender Piece		Fear/Anger piece		Joy Piece	
Wanting to attack something	Mellowed	-.22*	Anxious	.31*	Anxious	.26*
	Soothed	-.20*	Irritated	.47**	Irritated	.23*
	Nostalgic	-.14*	Uninterested	.19*		
	Irritated	.33**				
Wanting to make the experience longer	Mellowed	.49**	Mellowed	.21*	Mellowed	.28*
	Soothed	.39**	Soothed	.28*	Sad	.20*
	Nostalgic	.37**	Happy	.23*	Soothed	.32**
	Happy	.39**	Anxious	-.24*	Nostalgic	.19*
	Anxious	-.17*	Triumphant	.32*	Happy	.46**
	Triumphant	.25*	Admiring	.29*	Triumphant	.42**
	Admiring	.51*	Transcendent	.27*	Admiring	.52**
	Transcendent	.46*	Irritated	-.21*	Transcendent	.39**
	Irritated	-.27*			Uninterested	-.22*
	Uninterested	-.55**				
Feeling like crying	Sad	.59**	Sad	.38**	Sad	.18*
	Soothed	-.20*	Anxious	.41**	Transcendent	.25*
	Nostalgic	.47**	Irritated	.29*		
	Happy	-.23*				
	Uninterested	-.23*				
Feeling like boiling inside	none		Anxious	.25*	Sad	.22*
			Admiring	.25*	Triumphant	.21*
			Transcendent	.21*		
			Irritated	.34*		
Feeling in command of the situation	Soothed	.22*	Happy	.21*	Soothed	.26*
	Happy	.36**	Triumphant	.54**	Happy	.40*
	Triumphant	.23*	Admiring	.19*	Anxious	-.20*
			Transcendent	.22*	Triumphant	.40**
					Admiring	.32**
					Transcendent	.27*
Feeling frozen	Sad	.22*	Sad	.20*	Anxious	.22*
	Happy	-.27*	Happy	-.25*		
	Irritated	.34**	Anxious	.51**		
			Irritated	.36**		
Wanting to jump around	Sad	-.32**	Happy	.27*	Happy	.40**
	Nostalgic	-.24**	Triumphant	.26*	Triumphant	.37**
	Happy	.30*	Admiring	.28*	Admiring	.40**
			Transcendent	.23*	Transcendent	.29*
Feeling like laughing	Mellowed	.20*	Sad	-.19*	Mellowed	.24*
	Sad	-.23*	Happy	.21*	Nostalgic	.24*
	Happy	.28*	Anxious	-.20*	Happy	.49**
	Uninterested	-.21*	Transcendent	.22*	Triumphant	.31*
					Admiring	.32*
					Transcendent	.27*

N= 124

Correlation statistic: Spearman's Rho

* = $p < 0.05$, ** = $p < 0.001$ (2-tailed).

7.5.3 Manipulation check I: Which emotions and Subjective Feelings were Associated with Each Stimulus?

7.5.3.1 Sadness/tenderness piece:

The **induced emotions** with mean scores above 1.0 after listening to the Sadness/Tenderness piece were: *Mellowed*, *Soothed*, *Nostalgic*, *Filled-with-Admiration*, and *Transcendent*. Contrary to expectation, ratings of induced *Sadness* were not among the highest (mean = 0.97), but ratings of *Happiness* were (mean = 1.40). It seems that most participants experienced emotions related to relaxation and bitter-sweet emotions (like nostalgia) rather than negative emotions while listening to this piece. This conclusion is supported by the analysis of the mean ratings of **perceived emotions**, which in descending order were: *Peacefulness, Longing Tenderness, Spirituality*, and *Melancholy.* (See Table 10.1, in Appendix 2 for means and standard deviations).

An analysis of the mean scores from the **Subjective Feelings & Action Tendencies** questionnaire confirms that most participants had a relaxed and bitter-sweet experience while listening to this piece. (Means and standard deviations displayed in Table 10.2, in Appendix 2).

7.5.3.2 Fear/anger piece:

The two **induced emotions** with the highest ratings after listening to the Fear/ Anger piece were *Anxious*, and *Triumphant*, with means above 1.0; followed by: *Admiring*, *Irritated*, and *Sad,* with ratings between 0.51 and 0.98. The **perceived emotions** with the highest ratings were: *Fear, Pride, Anger* and *Melancholy*. (Table 10.3 in Appendix 2 shows the means and standard deviations for all the items). This finding suggests that a large proportion of participants experienced this piece of music as expressive of “pride” and “power”, and this corresponded to the experience of feeling “strong” or “triumphant” themselves, rather than scared or irritated.

The analysis of the most frequently reported **Subjective Feelings and Action Tendencies** also shows that some participants felt predominantly negative affective states, whereas other felt more positive ones. (See table 10.4, in Appendix 2 for means and standard deviations).

7.5.3.3 Joy piece:

In line with the prediction, the **induced emotions** with highest ratings after listening to the Joy piece were: *Happy, Triumphant,* and *Soothed.* The next ones were: *Mellowed*, *Admiring*, and *Transcendent* (all with mean scores above 1.0). The **perceived emotions** with highest mean scores, (above 1.0) for this piece were: *Joy*, *Peacefulness, Tenderness and Spirituality.* (Table 10.5 in Appendix 2 presents the means and standard deviations).

An analysis of the answers to the **Subjective Feelings & Action Tendencies** questionnaire confirms that the participants experienced mostly positive affective states while listening to this piece. (See Table 10.6, in Appendix 2 for means and standard deviations).

It can be concluded, from the analyses presented above, that the three experimental stimuli were successful at expressing and inducing the target emotions.

7.5.4 Manipulation Check II: Do Reports of Perceived and Induced Emotions Correlate?

An essential condition for establishing that *emotional contagion* in music has occurred is that listeners' reports of perceived and induced emotions while listening to music should be coherent. This condition is largely supported by the data: in all three pieces, the participants reported experiencing corresponding *perceived* and *induced* emotions. Overall, the Spearman correlation coefficients range from .20 to .69 (median = .45, all p values < .005). (See tables 10.7, 10.8 and 10.9 in Appendix 2 for summaries of the correlation analyses).

7.5.5 Test of Hypothesis 1: Did the Participants in the Simulation Groups Experience More Intense Induced Emotions?

Testing Hypotheses 1A, 1B and 1C involves establishing which were the most intensely induced and perceived affective states for each piece; to this end, I created the new following set of dependent variables:

- *Most Intense Induced Emotion:* the highest score for each participant in the questionnaire of Induced Emotions, regardless of the type of emotion.

- *Most Intense Induced Affect:* in this case, I also included the ratings of induced core affect. I created this variable because I observed that some participants rated their emotional experience by using items related to *core affect* (e.g. "pleasant") rather than using items related to *discrete* emotions (e.g. "mellowed", "soothed" or "happy").
- *Most Intense Action Tendency:* the highest score for each participant in the questionnaire of Subjective Feelings & Action Tendencies.
- *Most Intense Perceived Emotion:* the highest score reported by each participant in the questionnaire of perceived emotions, regardless of the type of emotion.
- *Most Intense Perceived Affect:* In this case, I included the ratings of perceived affect. (The rationale for creating this variable is the same as for creating the "most intense induced affect" variable).

Since none of these dependent variables were normally distributed, I used the non-parametric Kruskal-Wallis test to compare the group means. Furthermore, as follow-up analyses, I also used this type of test to determine the effect of the simulation manipulation on the participants' reports of core affect, and on the scores of the induced, perceived emotions, subjective feelings and action tendencies with the highest mean ratings (as described in the section 7.4.3). In order to control for the probability of making Type I errors, in all of these statistical tests, the Bonferroni correction was applied to the p-values in all the post-hoc comparisons.

7.5.5.1 Sadness/tenderness piece:

When examining the most intense affective states the prediction made in **Hypothesis 1A** is partially observed: the Motor Simulation group had slightly higher, but not statistically significant scores in almost all of these measures: *Most Intense Induced Discrete Emotion, Most Intense Perceived Affect, Most Intense Perceived Discrete Emotion,* and *Most Intense Action Tendency* (all p-values > .05). In contrast, the prediction is not observed in the Vocal Simulation group. Contrary to expectation, this group had the lowest scores in all of these dependent measures.

Also contrary to the prediction made in **Hypothesis 1B**, the Distracting Task group did not have the lowest scores of all groups, on the contrary, this group had some of the highest scores in these measures, although the differences with the other groups are not large enough to be statistically significant.

Regarding **Hypothesis 1C**, which predicted that the Stationary group's scores would fall between the scores of the *Simulation* groups and the Distracting Task groups, the observed trend supports the prediction in the case of induced states, but not in the case of the measures related to perception, where the Stationary group had the highest scores of all (all p-values > .005). (The means, standard deviations and standard errors are displayed in Table 7.5, and the results of the Kruskal-Wallis tests in table 7.9).

The follow-up analyses of the effects of simulation on the participants' **induced** discrete emotions yield a similar pattern of results.

In line with **Hypothesis 1A**, the Motor Simulation group had slightly higher scores of feeling *Mellowed, Transcendent,* and *Sad.* The Vocal Simulation group presented the lowest scores of feeling *Mellowed*, *Soothed*, *Nostalgic*, *Transcendent*, and *Sad*. The difference is significant in the case of *Mellowed,* where the Vocal Simulation group had lower scores than the Motor Simulation group H(3) = 9.20, p = .019 (r = .38).

The Distracting Task group only showed the trend expected from **Hypothesis 1B** (i.e. lowest scores) in the ratings of induced *Nostalgia*; and the Stationary group displayed the predicted trend in **Hypothesis 1C** in all of these measures, except on ratings of *Induced Nostalgia*, where it had the same scores as the Motor Simulation group, and ratings of *Induced Happiness*, where it had the lowest.

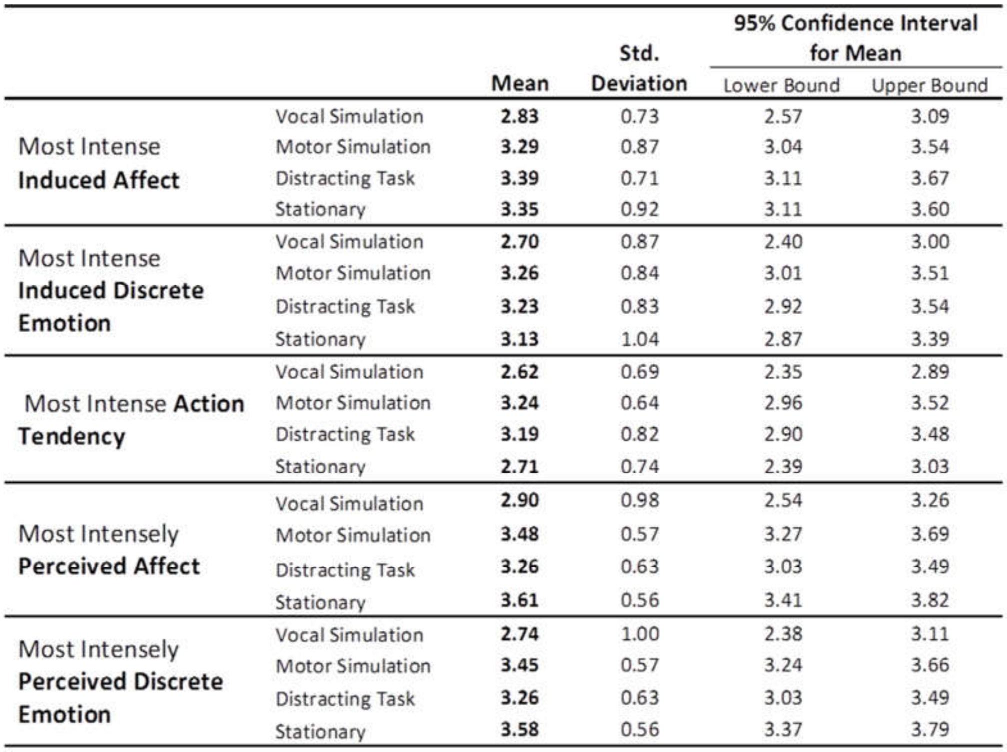
Regarding the measures of **perceived** affective states, the Kruskal-Wallis tests do not yield a pattern of results coherent with the hypotheses. Thus, as could be expected from **Hypothesis 1A**, the Motor Simulation group had significantly higher scores of perceived *Tenderness* H(3) = 12.76 than the other groups: Vocal simulation p = .015, (r = .038), Stationary p = .024 (r = 0.36); and Distracting Task p = .028 (r = .36). (The Motor Simulation group also had the highest scores of perceived Spirituality and Melancholy, p's > 0.05). Contrary to the expectation, the Vocal Simulation group had the lowest scores of perceived *Peacefulness, Melancholy, Spirituality* and *Tenderness.*

The only cases where the Distracting Task group had the predicted lowest ratings were *Perceived Longing*, and *Spirituality* (**Hypothesis 1B**) (p's > 0.05); and the Stationary group did not display mean scores that fell between the other groups' (**Hypothesis 1C**). (See table 7.7 for means and standard deviations).

Regarding the participants' reports of **core-affect** (valence, tense arousal and energetic arousal) the Kruskal-Wallis tests yields no significant differences between the groups. The observed trend was the following: both simulation groups had the lowest scores of *Valence*, while the Distracting Task group had the highest. The Motor Simulation group had the lowest scores of *Tense Arousal* (i.e. feeling more tension), while the Distracting Task had the highest (i.e. feeling more relaxed). The Stationary group had the lowest scores of *Energetic Arousal* (i.e. feeling more sleepy), while the Motor Simulation group had the highest (i.e. feeling more awake). (Table 7.6 displays the means and standard deviations).

Finally, the Kruskal-Wallis tests for the ratings of subjective feelings and action tendencies are consistent with the ratings of core-affect: the Motor Simulation group had significantly higher scores of *Wanting-to-make-the-experience-longer* than participants in the Stationary group H(3) = 10.28 p = .043 (r = .34); and participants in the Distracting Task group had significantly higher scores of *Feeling-in-command-of-the-situation* than the Stationary group H(3) = 11.41 p = .006 (r = .42). (See table 7.8 for means and standard deviations).

Table 7.5 *Most intense induced and perceived affective states in Sadness/Tenderness piece, as a function of listening condition*



		Mean	Std. Deviation	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Most Intense **Induced Affect**	Vocal Simulation	**2.83**	0.73	2.57	3.09
	Motor Simulation	**3.29**	0.87	3.04	3.54
	Distracting Task	**3.39**	0.71	3.11	3.67
	Stationary	**3.35**	0.92	3.11	3.60
Most Intense **Induced Discrete Emotion**	Vocal Simulation	**2.70**	0.87	2.40	3.00
	Motor Simulation	**3.26**	0.84	3.01	3.51
	Distracting Task	**3.23**	0.83	2.92	3.54
	Stationary	**3.13**	1.04	2.87	3.39
Most Intense **Action Tendency**	Vocal Simulation	**2.62**	0.69	2.35	2.89
	Motor Simulation	**3.24**	0.64	2.96	3.52
	Distracting Task	**3.19**	0.82	2.90	3.48
	Stationary	**2.71**	0.74	2.39	3.03
Most Intensely **Perceived Affect**	Vocal Simulation	**2.90**	0.98	2.54	3.26
	Motor Simulation	**3.48**	0.57	3.27	3.69
	Distracting Task	**3.26**	0.63	3.03	3.49
	Stationary	**3.61**	0.56	3.41	3.82
Most Intensely **Perceived Discrete Emotion**	Vocal Simulation	**2.74**	1.00	2.38	3.11
	Motor Simulation	**3.45**	0.57	3.24	3.66
	Distracting Task	**3.26**	0.63	3.03	3.49
	Stationary	**3.58**	0.56	3.37	3.79

Table 7.6 *Core affect in Sadness/Tenderness piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Induced Valence	Vocal Simulation	**1.61**	1.09	1.21	2.01
	Motor Simulation	**1.61**	1.41	1.74	2.78
	Distracting Task	**2.23**	1.50	1.68	2.78
	Stationary	**1.97**	1.74	1.33	2.61
Induced Tense Arousal	Vocal Simulation	**1.65**	1.20	1.21	2.08
	Motor Simulation	**2.19**	1.47	1.65	2.73
	Distracting Task	**2.52**	1.29	2.04	2.99
	Stationary	**2.13**	1.71	1.50	2.76
Induced Energetic Arousal	Vocal Simulation	**0.13**	1.52	-0.43	0.69
	Motor Simulation	**0.26**	1.24	-0.20	0.71
	Distracting Task	**0.06**	2.10	-0.70	0.83
	Stationary	**-0.32**	1.49	-0.87	0.22

Table 7.7 *Most frequently reported induced and perceived discrete emotions in Sadness/Tenderness piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Mellowed	Vocal Simulation	**1.63**	1.16	1.20	2.07
	Motor Simulation	**2.55**	1.09	2.15	2.95
	Distracting Task	**2.19**	1.22	1.75	2.64
	Stationary	**1.97**	1.30	1.49	2.45
Soothed	Vocal Simulation	**2.03**	1.03	1.65	2.42
	Motor Simulation	**2.26**	1.12	1.85	2.67
	Distracting Task	**2.29**	1.35	1.80	2.78
	Stationary	**2.06**	1.24	1.61	2.52
Nostalgic	Vocal Simulation	**1.63**	1.03	1.25	2.02
	Motor Simulation	**2.19**	1.42	1.67	2.72
	Distracting Task	**1.55**	1.34	1.06	2.04
	Stationary	**2.19**	1.28	1.73	2.66
Transcendent, Inspired	Vocal Simulation	**1.13**	1.07	0.73	1.53
	Motor Simulation	**1.81**	1.22	1.36	2.25
	Distracting Task	**1.52**	1.34	1.03	2.01
	Stationary	**1.65**	1.20	1.65	1.21
Sad	Vocal Simulation	**0.73**	0.91	0.39	1.07
	Motor Simulation	**1.32**	1.14	0.91	1.74
	Distracting Task	**0.87**	1.15	0.45	1.29
	Stationary	**0.94**	0.93	0.59	1.28
Happy	Vocal Simulation	**1.30**	1.09	0.89	1.71
	Motor Simulation	**1.52**	1.12	1.10	1.93
	Distracting Task	**1.52**	1.18	1.08	1.95
	Stationary	**1.26**	0.96	0.90	1.61
Perceived Peacefulness	Vocal Simulation	**2.27**	0.98	1.90	2.63
	Motor Simulation	**2.77**	0.84	2.46	3.08
	Distracting Task	**2.58**	1.18	2.15	3.01
	Stationary	**2.77**	1.09	2.38	3.17
Perceived Longing	Vocal Simulation	**2.33**	1.24	1.87	2.80
	Motor Simulation	**2.58**	1.23	2.13	3.03
	Distracting Task	**2.13**	1.26	1.67	2.59
	Stationary	**2.84**	1.10	2.44	3.24
Perceived Tenderness	Vocal Simulation	**2.27**	0.98	1.90	2.63
	Motor Simulation	**3.00**	0.93	2.66	3.34
	Distracting Task	**2.32**	1.01	1.95	2.69
	Stationary	**2.29**	0.97	1.93	2.65
Perceived Spirituality	Vocal Simulation	**1.37**	1.13	0.95	1.79
	Motor Simulation	**2.03**	0.98	1.67	2.39
	Distracting Task	**1.68**	1.45	1.15	2.21
	Stationary	**1.81**	1.01	1.43	2.18
Perceived Melancholy	Vocal Simulation	**1.13**	1.11	0.72	1.55
	Motor Simulation	**1.42**	1.23	0.97	1.87
	Distracting Task	**1.35**	1.36	0.86	1.85
	Stationary	**1.35**	1.20	0.92	1.79

Table 7.8 *Most frequently reported subjective feelings in Sadness/Tenderness piece, as a function of listening condition*

		Mean	Std Deviation	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Needing to be comforted	Vocal Simulation	**0.81**	0.81	0.44	1.18
	Motor Simulation	**1.19**	1.25	0.74	1.65
	Distracting Task	**0.87**	1.09	0.47	1.27
	Stationary	**0.84**	0.93	0.50	1.18
Wanting to dance	Vocal Simulation	**0.57**	1.03	0.10	1.04
	Motor Simulation	**0.97**	1.14	0.55	1.39
	Distracting Task	**1.10**	1.16	0.67	1.52
	Stationary	**0.45**	0.96	0.10	0.80
Feeling like everything is fine	Vocal Simulation	**2.24**	0.70	1.92	2.56
	Motor Simulation	**2.26**	1.18	1.82	2.69
	Distracting Task	**2.19**	1.38	1.69	2.70
	Stationary	**2.00**	1.21	1.56	2.44
Not being able to concentrate	Vocal Simulation	**0.52**	0.81	0.15	0.89
	Motor Simulation	**0.58**	1.06	0.19	0.97
	Distracting Task	**0.94**	1.09	0.53	1.34
	Stationary	**0.39**	0.72	0.12	0.65
Wanting to make the experience longer	Vocal Simulation	**1.52**	1.17	0.99	2.06
	Motor Simulation	**2.48**	1.21	2.04	2.93
	Distracting Task	**2.13**	1.43	1.60	2.65
	Stationary	**1.58**	1.26	1.12	2.04
Wanting to understand more	Vocal Simulation	**1.38**	1.24	0.81	1.95
	Motor Simulation	**1.90**	1.22	1.46	2.35
	Distracting Task	**1.71**	1.30	1.23	2.19
	Stationary	**1.71**	1.16	1.28	2.14
Feeling like things do not involve me	Vocal Simulation	**0.52**	0.98	0.08	0.97
	Motor Simulation	**0.65**	0.95	0.30	0.99
	Distracting Task	**0.87**	1.15	0.45	1.29
	Stationary	**0.58**	0.81	0.28	0.88
Feeling like crying	Vocal Simulation	**0.33**	0.58	0.07	0.60
	Motor Simulation	**0.68**	0.94	0.33	1.02
	Distracting Task	**0.71**	1.04	0.33	1.09
	Stationary	**0.61**	0.92	0.28	0.95
Feeling in command of the situation	Vocal Simulation	**0.90**	0.83	0.53	1.28
	Motor Simulation	**1.19**	1.08	0.80	1.59
	Distracting Task	**1.58**	1.23	1.13	2.03
	Stationary	**0.65**	0.84	0.34	0.95

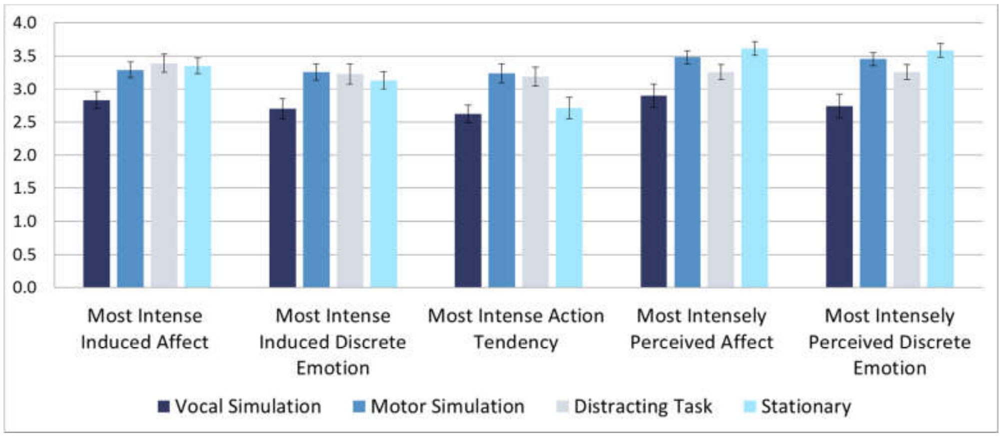


Figure 7.3 Means ratings of most intense induced and perceived affective states in Sadness/Tenderness piece, as a function of listening condition.

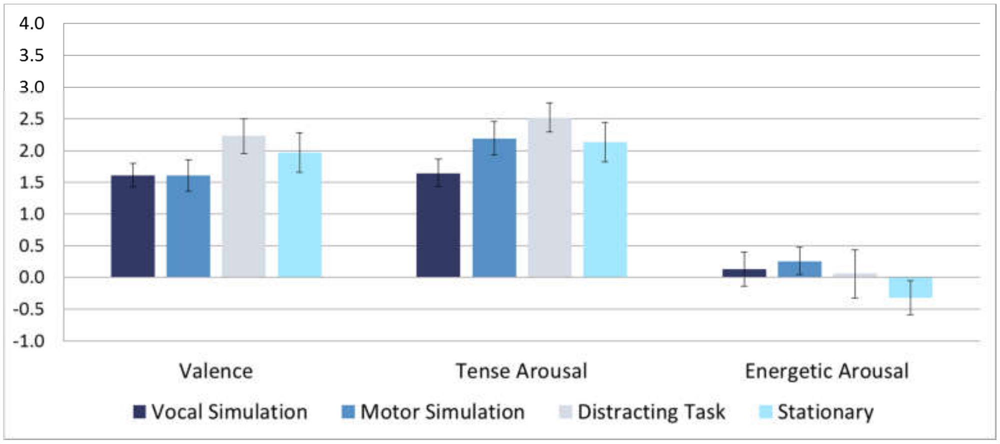


Figure 7.4 Mean ratings of core affect in Sadness/Tenderness piece as a function of listening condition.

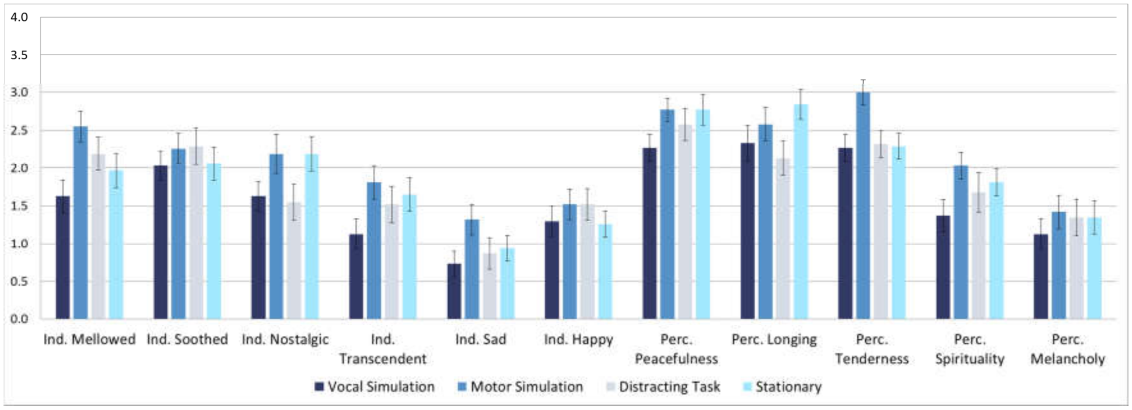


Figure 7.5 Mean ratings of the most frequently induced and perceived discrete emotions in Sadness/Tenderness piece, as a function of listening condition.

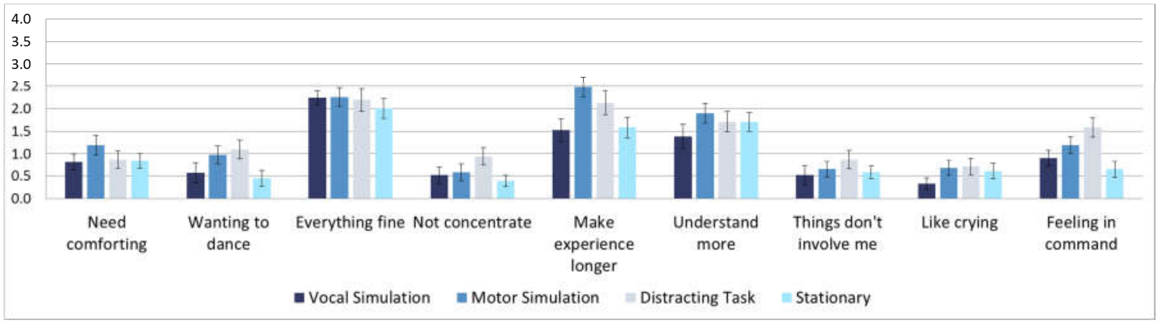
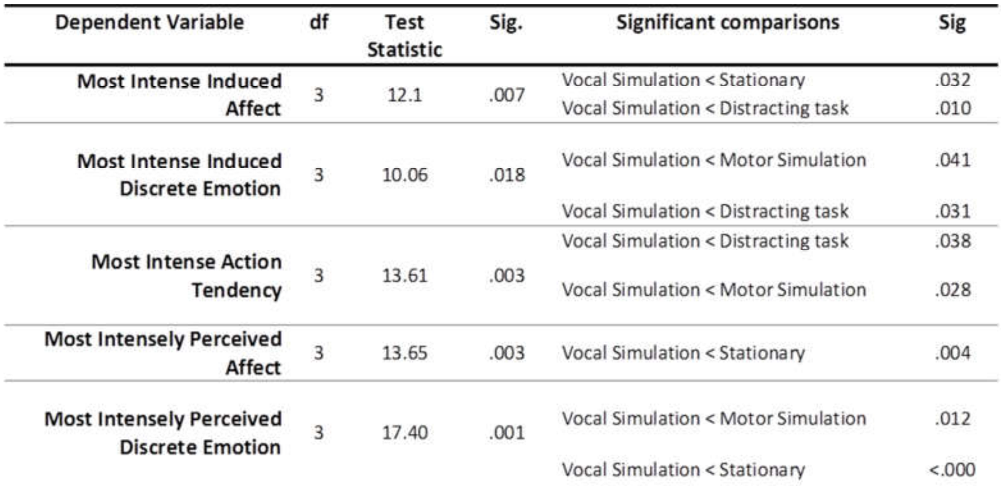


Figure 7.6 Mean ratings of subjective feelings in Sadness / Tenderness piece, as a function of listening condition.

Table 7.9 *Kruskal-Wallis test of most intense induced and perceived affects in Sadness/Tenderness piece*



Dependent Variable	df	Test Statistic	Sig.	Significant comparisons	Sig
Most Intense Induced Affect	3	12.1	.007	Vocal Simulation < Stationary	.032
				Vocal Simulation < Distracting task	.010
Most Intense Induced Discrete Emotion	3	10.06	.018	Vocal Simulation < Motor Simulation	.041
				Vocal Simulation < Distracting task	.031
Most Intense Action Tendency	3	13.61	.003	Vocal Simulation < Distracting task	.038
				Vocal Simulation < Motor Simulation	.028
Most Intensely Perceived Affect	3	13.65	.003	Vocal Simulation < Stationary	.004
Most Intensely Perceived Discrete Emotion	3	17.40	.001	Vocal Simulation < Motor Simulation	.012
				Vocal Simulation < Stationary	<.000

7.5.5.2 Fear/anger Piece:

Hypothesis 1A predicted that the simulation groups would have higher scores of induced and perceived emotions than the rest. This prediction is partially observed in the data, but the Kruskal-Wallis tests did not yield any significant differences between the groups in any of these dependent measures (all p-values > .005): the Motor Simulation group had the highest scores of *Most Intense Induced Affect,* and *Most Intense Induced Discrete Emotion*. Once more, the Vocal Simulation group showed a trend which was opposite to the prediction, with the lowest scores of *Most Intense Induced Affect, Most Intense Induced Discrete Emotion,* and *Most Intense Action Tendency.*

Hypothesis 1B predicted that the Distracting Task group would have the lowest mean scores is observed in two of the measures, but these differences are non-significant.

The prediction made in **Hypothesis 1C** is observed in most the cases, the Stationary group had scores that were between those of the *Simulation group* and the Distracting Task group in most of the measures. However, there were not any significant differences between the groups in these ratings. (See table 7.10 for means and standard deviations, and Table 7.14 for the results of the Kruskal-Wallis tests).

The follow-up analyses of the participants' ratings of discrete emotions shows that the participants in the Motor Simulation group condition tended to feel more intensely those emotions that have to do with feeling empowered: they reported slightly higher ratings of feeling *Triumphant*, *Admiring* and *Irritated,* and *Perceived Anger* (but also of *Perceived Melancholy*). These differences are marginally significant in the case of *Triumphant* ratings H(3) = 9.14, p = .061.

Contrary to what could be expected from **Hypothesis 1A**, the Vocal Simulation group had the lowest scores of *Induced Anxious, Induced Admiration, Perceived Anger, Perceived Melancholy, Perceived Spirituality* and *Perceived Fear*, where it had significantly lower scores than the Stationary group H(3) = 10.42 p = .036 (r= .35).

Also contrary to what was expected from **Hypothesis 1B**, the Distracting Task group did not display the lowest ratings in any of these dependent measures. The prediction from **Hypothesis 1C** is not observed in the data either. Interestingly, the mean ratings of *Perceived Fear* in the Stationary group were significantly higher than in the Motor Simulation group H(3) = 10.42 p = .041 (r= .34). (See Table 7.12 for means and standard deviations).

The analysis of the ratings of **core-affect** yielded no significant differences between the groups. The observed trend was the following: the Motor Simulation group had the highest mean scores of *Valence*, and the Stationary group had the lowest. The lowest scores of *Tense Arousal* were found in the Stationary group (i.e. they felt more tense), and the highest in the *Vocal Simulation* group (i.e. they felt more relaxed). The highest scores of *Energetic Arousal* were observed in the Motor Simulation group (i.e. they felt more awake), and the lowest in the Distracting Task group (i.e. they felt more drowsy). (Table 7.11 summarizes the means and standard deviations information).

The results from the **Subjective Feelings & Action Tendencies** questionnaire confirms the finding that the participants in the Stationary group had the most negative experience of all the groups, and suggests that this was probably because the instruction of staying still while listening to this piece of music made them feel "helpless". The Stationary group had lower scores of *Feeling-in-command-of-the-situation* than the Distracting Task group H(3) = 10.83 p = .022 (r = .37); higher scores of *Wanting-to-avoid-the-situation* than the Vocal Simulation group H(3) = 9.61 p = .029 (r = .36); higher scores of *Needing-to-be-comforted* than the Vocal Simulation group H(3) = 12.15 p = .003 (r = .44); and marginally higher scores of *Wanting-to-hide* than the Vocal Simulation group H(3) = 8.22 p = .053. (Table 7.13 presents the means and standard deviations).

Table 7.10 *Most intense induced and perceived affective states in Fear / Anger piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Error**	Lower Bound	Upper Bound
Most Intense **Induced Affect**	Vocal Simulation	**2.74**	0.16	2.41	3.07
	Motor Simulation	**3.06**	0.16	2.74	3.39
	Distracting Task	**2.90**	0.18	2.53	3.27
	Stationary	**3.03**	0.15	2.73	3.34
Most Intense **Induced Discrete Emotion**	Vocal Simulation	**2.55**	0.16	2.22	2.87
	Motor Simulation	**2.84**	0.18	2.47	3.21
	Distracting Task	**2.68**	0.19	2.29	3.06
	Stationary	**2.61**	0.18	2.25	2.98
Most Intense **Action Tendency**	Vocal Simulation	**2.77**	0.17	2.41	3.13
	Motor Simulation	**2.97**	0.15	2.66	3.27
	Distracting Task	**3.06**	0.14	2.78	3.35
	Stationary	**3.13**	0.15	2.82	3.44
Most Intensely Perceived **Affect**	Vocal Simulation	**3.52**	0.11	3.29	3.75
	Motor Simulation	**3.55**	0.11	3.32	3.78
	Distracting Task	**3.39**	0.15	3.08	3.70
	Stationary	**3.74**	0.09	3.55	3.93
Most Intensely Perceived **Discrete Emotion**	Vocal Simulation	**3.19**	0.16	2.87	3.51
	Motor Simulation	**3.35**	0.12	3.08	3.63
	Distracting Task	**3.19**	0.17	2.82	3.57
	Stationary	**3.58**	0.15	3.33	3.83

Table 7.11 *Core affect in Fear/Anger piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Induced Valence	Vocal Simulation	**-0.16**	0.34	-0.86	0.54
	Motor Simulation	**-0.23**	0.33	-0.89	0.44
	Distracting Task	**-0.55**	0.35	-1.26	0.16
	Stationary	**-0.77**	0.35	-1.48	-0.07
Induced Tense Arousal	Vocal Simulation	**-1.06**	0.31	-1.69	-0.44
	Motor Simulation	**-1.23**	0.34	-1.92	-0.53
	Distracting Task	**-1.10**	0.40	-1.91	-0.28
	Stationary	**-1.39**	0.35	-2.09	-0.68
Induced Energetic Arousal	Vocal Simulation	**1.61**	0.25	1.10	2.13
	Motor Simulation	**2.16**	0.23	1.70	2.63
	Distracting Task	**1.52**	0.25	1.00	2.03
	Stationary	**1.84**	0.21	1.40	2.27

Table 7.12 *Most frequently reported induced and perceived discrete emotions in Fear/ Anger piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Anxious	Vocal Simulation	**1.39**	1.12	0.98	1.80
	Motor Simulation	**1.65**	1.52	1.09	2.20
	Distracting Task	**1.48**	1.41	0.97	2.00
	Stationary	**1.87**	1.28	1.40	2.34
Triumphant	Vocal Simulation	**1.65**	1.31	1.17	2.12
	Motor Simulation	**1.77**	1.36	1.28	2.27
	Distracting Task	**1.77**	1.33	1.28	2.26
	Stationary	**0.94**	1.24	0.48	1.39
Admiring	Vocal Simulation	**0.77**	1.06	0.39	1.16
	Motor Simulation	**1.13**	1.15	0.71	1.55
	Distracting Task	**1.06**	1.18	0.63	1.50
	Stationary	**0.94**	1.00	0.57	1.30
Irritated	Vocal Simulation	**0.74**	1.00	0.38	1.11
	Motor Simulation	**1.19**	1.25	0.74	1.65
	Distracting Task	**1.16**	1.21	0.72	1.61
	Stationary	**0.61**	0.88	0.29	0.94
Sad	Vocal Simulation	**0.65**	0.84	0.34	0.95
	Motor Simulation	**0.97**	1.08	0.57	1.36
	Distracting Task	**1.06**	1.15	0.64	1.49
	Stationary	**0.52**	0.85	0.20	0.83
Perceived Fear	Vocal Simulation	**2.48**	1.18	2.05	2.92
	Motor Simulation	**2.45**	1.29	1.98	2.92
	Distracting Task	**2.61**	1.12	2.20	3.02
	Stationary	**3.23**	1.06	2.84	3.61
Perceived Pride	Vocal Simulation	**2.39**	1.41	1.87	2.90
	Motor Simulation	**2.48**	1.18	2.05	2.92
	Distracting Task	**2.55**	1.46	2.01	3.08
	Stationary	**2.35**	1.33	1.87	2.84
Perceived Anger	Vocal Simulation	**1.90**	1.14	1.49	2.32
	Motor Simulation	**2.23**	1.31	1.75	2.71
	Distracting Task	**2.03**	1.35	1.54	2.53
	Stationary	**2.10**	1.25	1.64	2.55
Perceived Melancholy	Vocal Simulation	**0.84**	0.97	0.48	1.19
	Motor Simulation	**1.35**	1.02	0.98	1.73
	Distracting Task	**1.32**	1.11	0.92	1.73
	Stationary	**1.00**	0.97	0.65	1.35
Perceived Spirituality	Vocal Simulation	**0.81**	1.05	0.42	1.19
	Motor Simulation	**1.00**	1.18	0.57	1.43
	Distracting Task	**1.10**	1.37	0.59	1.60
	Stationary	**1.06**	1.03	0.69	1.44

Table 7.13 *Most Frequently reported subjective feelings in Fear/ Anger piece, as a function of listening condition*

				95% Confidence Interval for Mean		
		Mean	**Std Deviation**	Lower Bound	Upper Bound	**Std. Error**
Needing to be comforted	Vocal Simulation	**0.35**	0.88	0.03	0.68	0.16
	Motor Simulation	**0.61**	0.99	0.25	0.98	0.18
	Distracting Task	**0.71**	1.01	0.34	1.08	0.18
	Stationary	**1.23**	1.26	0.76	1.69	0.23
Feeling like everything is fine	Vocal Simulation	**1.00**	1.11	0.51	1.49	0.24
	Motor Simulation	**0.90**	1.11	0.50	1.31	0.20
	Distracting Task	**1.00**	1.18	0.57	1.43	0.21
	Stationary	**0.42**	0.92	0.08	0.76	0.17
Not being able to concentrate	Vocal Simulation	**0.82**	1.05	0.35	1.28	0.22
	Motor Simulation	**1.13**	1.20	0.69	1.57	0.22
	Distracting Task	**1.77**	1.28	1.30	2.24	0.23
	Stationary	**1.26**	1.03	0.88	1.64	0.19
Wanting to avoid the situation	Vocal Simulation	**0.86**	1.32	0.28	1.45	0.28
	Motor Simulation	**1.03**	1.30	0.55	1.51	0.23
	Distracting Task	**1.35**	1.40	0.84	1.87	0.25
	Stationary	**1.84**	1.39	1.33	2.35	0.25
Wanting to hide away	Vocal Simulation	**1.05**	1.09	0.56	1.53	0.23
	Motor Simulation	**1.35**	1.47	0.81	1.90	0.26
	Distracting Task	**1.42**	1.29	0.95	1.89	0.23
	Stationary	**2.03**	1.33	1.54	2.52	0.24
Wanting to attack something	Vocal Simulation	**0.82**	0.96	0.39	1.24	0.20
	Motor Simulation	**0.68**	1.19	0.24	1.12	0.21
	Distracting Task	**0.87**	1.15	0.45	1.29	0.21
	Stationary	**0.61**	1.02	0.24	0.99	0.18
Wanting to make the experience longer	Vocal Simulation	**1.00**	1.07	0.53	1.47	0.23
	Motor Simulation	**1.32**	1.28	0.85	1.79	0.23
	Distracting Task	**0.97**	1.20	0.53	1.41	0.21
	Stationary	**0.61**	0.72	0.35	0.88	0.13
Wanting to understand more	Vocal Simulation	**1.27**	1.16	0.76	1.79	0.25
	Motor Simulation	**1.87**	1.20	1.43	2.31	0.22
	Distracting Task	**1.77**	1.28	1.30	2.24	0.23
	Stationary	**1.26**	1.24	0.80	1.71	0.22
Feeling like things do not involve me	Vocal Simulation	**0.55**	0.96	0.12	0.97	0.21
	Motor Simulation	**0.94**	1.24	0.48	1.39	0.22
	Distracting Task	**0.84**	1.00	0.47	1.21	0.18
	Stationary	**0.55**	0.85	0.24	0.86	0.15
Feeling like boiling inside	Vocal Simulation	**0.50**	0.86	0.12	0.88	0.18
	Motor Simulation	**0.87**	1.26	0.41	1.33	0.23
	Distracting Task	**0.77**	1.02	0.40	1.15	0.18
	Stationary	**0.65**	1.02	0.27	1.02	0.18
Feeling in command of the situation	Vocal Simulation	**1.18**	1.22	0.64	1.72	0.26
	Motor Simulation	**1.06**	1.09	0.66	1.47	0.20
	Distracting Task	**1.13**	0.96	0.78	1.48	0.17
	Stationary	**0.45**	0.81	0.15	0.75	0.15
Feeling frozen	Vocal Simulation	**0.59**	0.67	0.30	0.89	0.14
	Motor Simulation	**0.97**	1.11	0.56	1.37	0.20
	Distracting Task	**0.90**	0.94	0.56	1.25	0.17
	Stationary	**1.23**	1.18	0.79	1.66	0.21

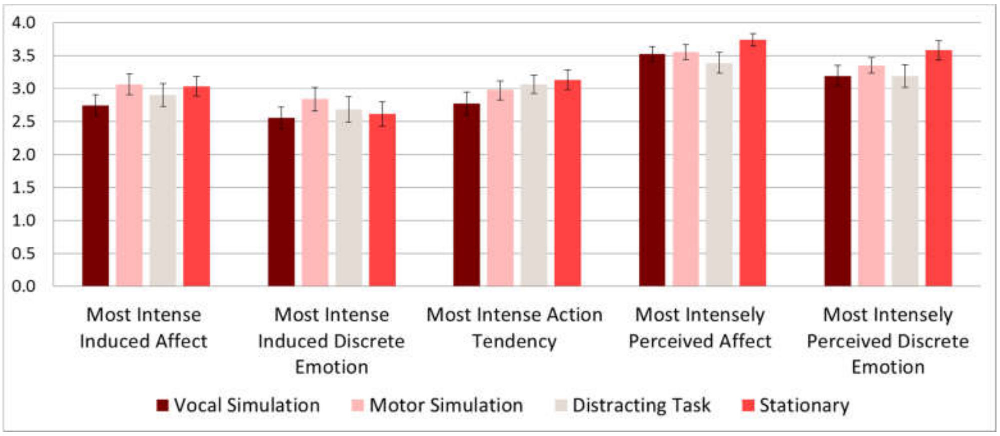


Figure 7.7 Means ratings of most intense induced and perceived affective states in Fear/ Anger piece, as a function of listening condition.

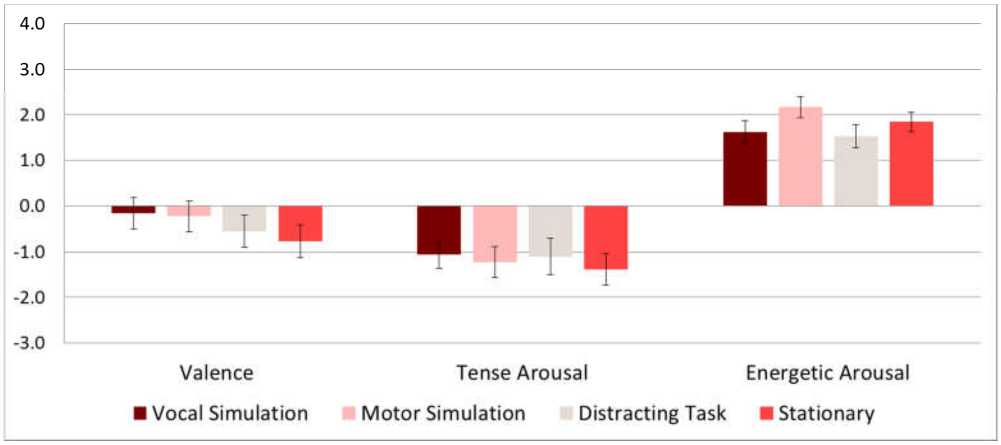


Figure 7.8 Mean ratings of core affect in Fear/ Anger piece, as a function of listening condition.

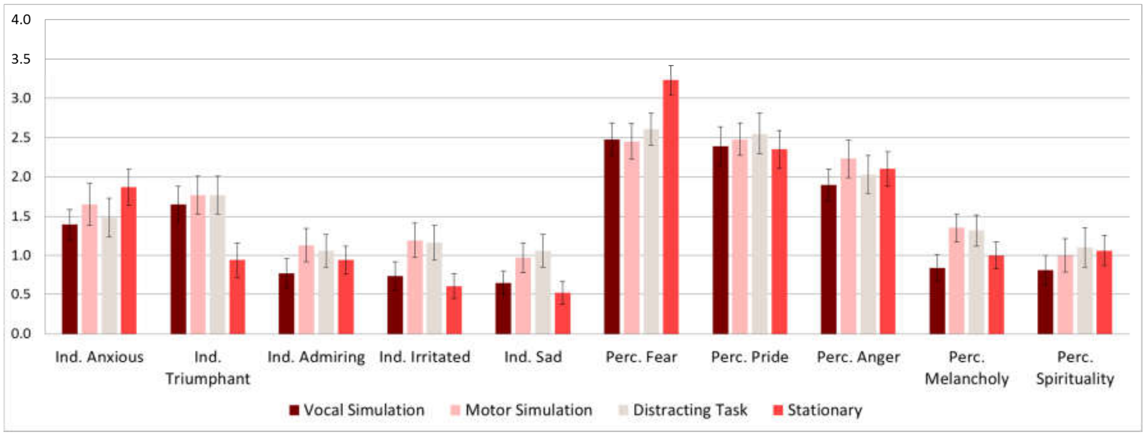


Figure 7.9 Mean ratings of induced and discrete emotions in Fear / Anger piece, as a function of listening condition.

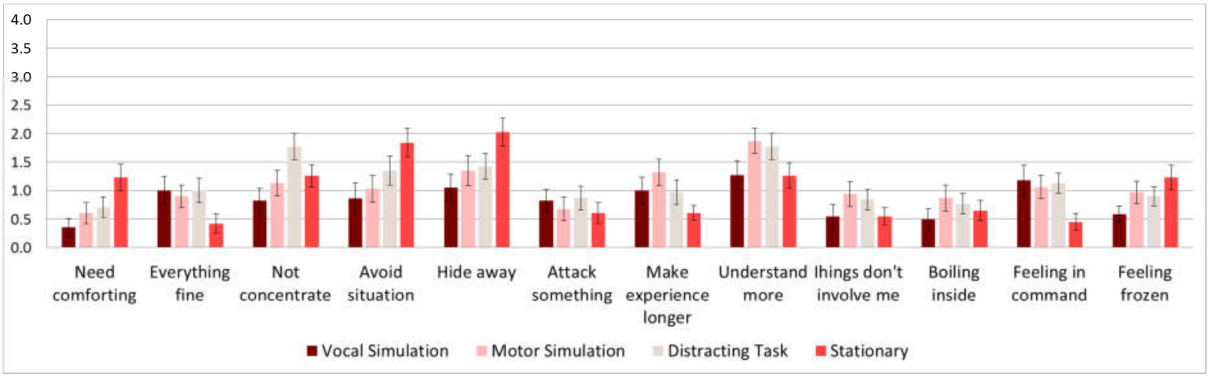


Figure 7.10 Mean ratings of subjective feelings in Fear/Anger piece, as a function of listening condition.

Table 7.14 *Kruskal-Wallis test of most intense induced and perceived affects in Fear / Anger piece*

Dependent Variable	df	Test Statistic	Sig.
Most Intense Induced Affect	3	2.32	.510
Most Intense Induced Discrete Emotion	3	1.76	.624
Most Intense Action Tendency	3	2.76	.431
Most Intensely Perceived Affect	3	3.83	.281
Most Intensely Perceived Discrete Emotion	3	4.00	.261

7.5.5.3 Joy piece:

The trends predicted from **Hypotheses 1A**, **1B** and **1C** are not observed in the data: the *Motor Simulation* group had the highest mean scores only in one of the dependent variables; the *Vocal Simulation* group had the lowest scores in all the dependent measures; the Distracting Task group did not have the lowest mean scores in any of these variables; and the Stationary group did not have the expected intermediate scores either. The Kruskal-Wallis tests indicate that there were no significant differences between the groups in any of these dependent measures. (Table 7.15 displays the means and standard deviations, and Table 7.19 displays the results of the Kruskal-Wallis tests).

The follow-up analyses of ratings of the most frequently reported discrete emotions yield results that do not completely coincide with the predictions either. Just like what could be expected from **Hypothesis 1A**, the Motor Simulation group had the highest scores in ratings of *Triumphant* (along with the Vocal Simulation group), and *Admiring*, and of perceived *Joy, Tenderness,* and *Spirituality.* The Vocal Simulation group, in contrast, had the lowest mean scores of all groups in ratings of*:* induced *Happy, Soothed,* and *Mellowed*; and of perceived *Joy, Tenderness,* and *Spirituality.* The differences are significant in the case of *Induced Soothed*, where the Vocal Simulation group had significantly lower scores than the Distracting Task group H(3) = 8.46 p = .039 (r = .35); and in the case of *Perceived Spirituality*, where it had significantly lower scores than the Motor Simulation group H(3) = 9.08 p = .023 (r = .37). (See Table 7.17 for means and standard deviations).

The analyses of the scores of **core affect**, yielded significant differences in *Tense Arousal* H(3) = 11.17, where the participants in the Vocal Simulation group reported feeling less relaxed than the participants in the Distracting Task group p = .006 (r = .42). (Means and standard deviations in Table 7.16).

Finally, the pattern of results from the **Subjective Feelings and Action Tendencies** questionnaire is partially coherent with the hypotheses. As could be expected from **Hypothesis 1A**, The *Motor Simulation* group had the highest scores of *Wanting-to-dance, Wanting-to-make-the-experience-longer, Wanting-to-understand-more, Wanting-to-jump-around,* and *Feeling-like-laughing.* Contrary to the prediction, the Vocal Simulation group had the lowest scores in all of the dependent variables, except in *Wanting-to-understand-more.* These differences between the groups are significant in *Feeling-like-everything-is-fine* H(3) = 11.11 and in *Wanting-to-dance* H(3) = 16.72. In the case of *Feeling-like-everything-is-fine*, the Vocal Simulation group had lower scores than the *Motor Simulation* group p = .035 (r =.35), the Stationary group p = .031 (r = .36) and the Distracting Task group p = .020 (r = .37). In the case of *Wanting-to-dance*, the Vocal Simulation group had lower scores than the Stationary group p = .025 (r = .36), and the Motor Simulation group p = .001 (r = .49).

Contrary to what could be expected from **Hypothesis 1B**, the Distracting Task group did not have the lowest scores in any of the variables. And finally, consistent with **Hypothesis 1C**, the Stationary group had intermediate scores in several variables, but these differences were nonsignificant. (Means and standard deviations in Table 7.18).

***Table 7.15** Most intense induced and perceived affective states in Joy piece, as a function of listening condition*

		Mean	**Std Deviation**	**95% Confidence Interval for Mean**	
				Lower Bound	Upper Bound
Most Intense Induced Affect	Vocal Simulation	**3.06**	0.73	2.80	3.33
	Motor Simulation	**3.19**	0.87	2.87	3.51
	Distracting Task	**3.35**	0.71	3.09	3.62
	Stationary	**3.39**	0.92	3.05	3.72
Most Intense Induced Discrete Emotion	Vocal Simulation	**2.68**	0.87	2.36	3.00
	Motor Simulation	**3.03**	0.84	2.73	3.34
	Distracting Task	**3.10**	0.83	2.79	3.40
	Stationary	**3.16**	1.04	2.78	3.54
Most Intense Action Tendency	Vocal Simulation	**3.00**	0.69	2.69	3.31
	Motor Simulation	**3.29**	0.64	3.05	3.53
	Distracting Task	**3.29**	0.82	2.99	3.59
	Stationary	**3.29**	0.74	3.02	3.56
Most Intensely Perceived Affect	Vocal Simulation	**3.32**	0.65	3.08	3.56
	Motor Simulation	**3.39**	0.67	3.14	3.63
	Distracting Task	**3.48**	0.77	3.20	3.77
	Stationary	**3.58**	0.67	3.33	3.83
Most Intensely Perceived Discrete Emotion	Vocal Simulation	**3.00**	0.89	2.67	3.33
	Motor Simulation	**3.16**	0.82	2.86	3.46
	Distracting Task	**3.03**	0.87	2.71	3.35
	Stationary	**3.06**	1.00	2.70	3.43

Table 7.16 *Core affect in Joy piece as a function of listening condition*

		Mean	**Std. Deviation**	**95% Confidence Interval for Mean**	
				Lower Bound	Upper Bound
Induced Valence	Vocal Simulation	**2.48**	0.89	2.16	2.81
	Motor Simulation	**2.61**	0.84	2.30	2.92
	Distracting Task	**2.68**	1.22	2.23	3.13
	Stationary	**2.97**	1.11	2.56	3.37
Induced Tense Arousal	Vocal Simulation	**1.23**	1.43	0.70	1.75
	Motor Simulation	**1.97**	1.05	1.58	2.35
	Distracting Task	**2.32**	1.47	1.78	2.86
	Stationary	**1.97**	1.54	1.40	2.53
Induced Energetic Arousal	Vocal Simulation	**2.16**	1.59	1.58	2.75
	Motor Simulation	**2.58**	1.39	2.07	3.09
	Distracting Task	**2.10**	1.37	1.59	2.60
	Stationary	**2.39**	1.26	1.93	2.85

Table 7.17 *Most frequently reported induced and perceived discrete emotions in Joy piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Happy	Vocal Simulation	**2.35**	0.95	2.01	2.70
	Motor Simulation	**2.77**	0.92	2.44	3.11
	Distracting Task	**2.74**	0.96	2.39	3.10
	Stationary	**2.87**	1.20	2.43	3.31
Triumphant	Vocal Simulation	**1.77**	1.20	1.33	2.22
	Motor Simulation	**1.77**	1.26	1.31	2.24
	Distracting Task	**1.74**	1.24	1.29	2.20
	Stationary	**1.48**	1.46	0.95	2.02
Soothed	Vocal Simulation	**1.19**	0.83	0.89	1.50
	Motor Simulation	**1.55**	0.77	1.27	1.83
	Distracting Task	**1.90**	1.11	1.50	2.31
	Stationary	**1.42**	1.26	0.96	1.88
Mellowed	Vocal Simulation	**1.19**	0.95	0.85	1.54
	Motor Simulation	**1.26**	1.06	0.87	1.65
	Distracting Task	**1.65**	1.28	1.18	2.11
	Stationary	**1.58**	0.99	1.22	1.94
Admiring	Vocal Simulation	**1.00**	1.10	0.60	1.40
	Motor Simulation	**1.84**	1.21	1.39	2.28
	Distracting Task	**1.39**	1.15	0.97	1.81
	Stationary	**1.35**	1.31	0.88	1.83
Perceived Joy	Vocal Simulation	**2.45**	1.06	2.06	2.84
	Motor Simulation	**2.87**	1.06	2.48	3.26
	Distracting Task	**2.81**	0.95	2.46	3.15
	Stationary	**2.81**	1.17	2.38	3.23
Perceived Peacefulness	Vocal Simulation	**1.35**	1.02	0.98	1.73
	Motor Simulation	**1.97**	1.14	1.55	2.39
	Distracting Task	**2.03**	1.25	1.57	2.49
	Stationary	**1.42**	1.43	0.89	1.94
Perceived Tenderness	Vocal Simulation	**1.10**	0.79	0.81	1.39
	Motor Simulation	**1.68**	1.19	1.24	2.12
	Distracting Task	**1.58**	1.15	1.16	2.00
	Stationary	**1.19**	1.14	0.78	1.61
Perceived Spirituality	Vocal Simulation	**0.84**	1.19	0.40	1.27
	Motor Simulation	**1.61**	1.15	1.19	2.03
	Distracting Task	**1.00**	1.13	0.59	1.41
	Stationary	**1.03**	0.91	0.70	1.37
Perceived Longing	Vocal Simulation	**1.00**	1.00	0.63	1.37
	Motor Simulation	**0.77**	0.92	0.44	1.11
	Distracting Task	**2.45**	1.06	2.06	2.84
	Stationary	**2.87**	1.06	2.48	3.26

Table 7.18 *Most Frequently reported subjective feelings in Joy piece, as a function of listening condition*

				95% Confidence Interval for Mean	
		Mean	**Std. Deviation**	Lower Bound	Upper Bound
Wanting to dance	Vocal Simulation	**1.13**	1.12	0.72	1.54
	Motor Simulation	**2.45**	1.06	2.06	2.84
	Distracting Task	**1.68**	1.45	1.15	2.21
	Stationary	**2.13**	1.45	1.60	2.66
Feeling like everything is fine	Vocal Simulation	**2.09**	0.81	1.73	2.45
	Motor Simulation	**2.81**	0.95	2.46	3.15
	Distracting Task	**2.84**	1.00	2.47	3.21
	Stationary	**2.81**	1.01	2.43	3.18
Wanting to make the experience longer	Vocal Simulation	**1.55**	1.14	1.04	2.05
	Motor Simulation	**2.58**	1.18	2.15	3.01
	Distracting Task	**2.10**	1.58	1.52	2.68
	Stationary	**2.13**	1.38	1.62	2.64
Wanting to understand more	Vocal Simulation	**1.95**	1.17	1.43	2.48
	Motor Simulation	**2.32**	1.25	1.86	2.78
	Distracting Task	**2.06**	1.31	1.58	2.55
	Stationary	**1.71**	1.37	1.21	2.21
Feeling in command of the situation	Vocal Simulation	**1.45**	0.91	1.05	1.86
	Motor Simulation	**1.45**	1.21	1.01	1.89
	Distracting Task	**2.29**	1.10	1.89	2.69
	Stationary	**1.68**	1.33	1.19	2.16
Wanting to jump around	Vocal Simulation	**1.23**	1.15	0.72	1.74
	Motor Simulation	**1.97**	1.40	1.45	2.48
	Distracting Task	**1.52**	1.39	1.01	2.03
	Stationary	**1.71**	1.47	1.17	2.25
Feeling like laughing	Vocal Simulation	**1.05**	1.05	0.58	1.51
	Motor Simulation	**1.81**	1.17	1.38	2.23
	Distracting Task	**1.42**	1.23	0.97	1.87
	Stationary	**1.71**	1.40	1.20	2.22

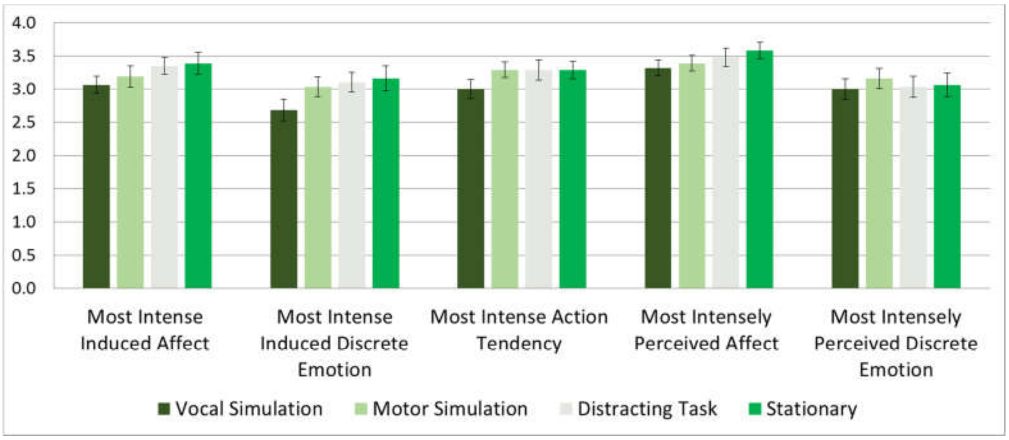


Figure 7.11 Means ratings of most intense induced and perceived affective states in Joy piece, as a function of listening condition.

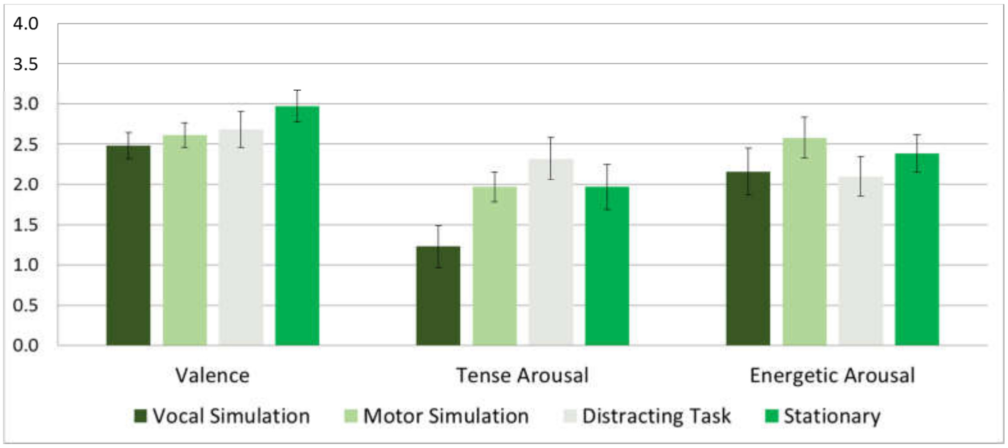


Figure 7.12 Mean ratings of core affect in Joy piece, as a function of listening condition.

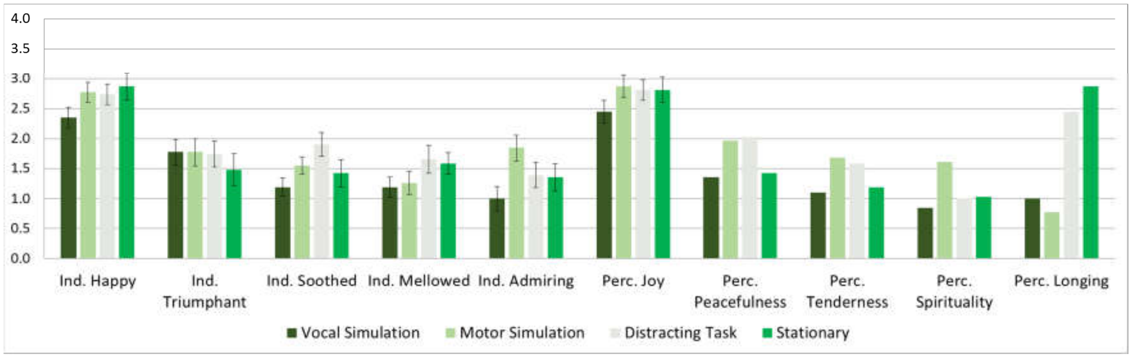


Figure 7.13 Mean ratings of the most frequently induced and perceived discrete emotions in Joy piece, as a function of listening condition.

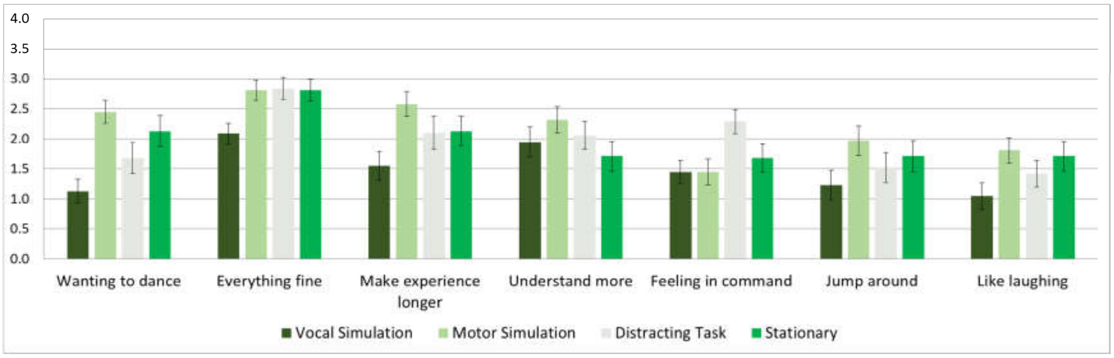


Figure 7.14 Mean ratings of subjective feelings in Joy piece, as a function of listening condition.

Table 7.19 *Kruskal-Wallis test of most intense induced and perceived affects in Joy piece*

Dependent Variable	df	Test Statistic	Sig.
Most Intense Induced Affect	3	5.03	.170
Most Intense Induced Discrete Emotion	3	7.25	.640
Most Intense Action Tendency	3	3.32	.344
Most Intensely Perceived Affect	3	3.93	.270
Most Intensely Perceived Discrete Emotion	3	.585	.900

7.5.6 Test of Hypothesis 1D: Did Any Covariates Significantly Mediate the Results?

In this section, I analyse the potential role of several covariates in the observed results, starting with the hypothesised positive mediating role that the ability of participants to play an instrument present in the piece would have on the dependent measures (Hypothesis 1D); and continuing with the other variables included in the post-experimental questionnaire.

Importantly, even though the assumption of normality was not met in most of the dependent variables, I used MANCOVA tests, which have been shown to be robust to these type of violations (Finch, 2005). As strategies to reduce the probability of making a Type I error, I first ran MANCOVA tests for all the dependent variables including all of the covariates, and then ran confirmatory ANCOVAs including only those covariates which the MANCOVA analyses identified as significant. The aims of doing this additional step were avoiding overfitting the regression models with nonsignificant variables, and ensuring that the Beta coefficients were not “inflated” by spurious correlations with other predictors. Additionally, in all the analyses I used Bootstrapping (set to 1000 iterations) to calculate the confidence intervals, I applied the Benjamini-Hochberg correction for multiple comparisons (Thissen, Steinberg, & Kuang, 2002), and I applied the Bonferroni correction to the p-values in the post-hoc tests.

The **covariates** included in the tests were:

- *Extent to which the participant is able to play a musical instrument present in the musical piece*. (The information provided by the participants about which instruments they can play was coded as an ordinal variable: not being able to play any instrument = 0; being able to play an instrument not present in the piece = 1; being able to play an instrument from the same category of instruments as those present in the piece = 2; being able to play an instrument present in the piece = 3).
- *Musical Engagement,*
- *Enjoyment* of the piece,
- *Familiarity* with the piece,
- Ratings of Perceived *Difficulty* in following the instructions for the task,
- Ratings of *Embarrassment* experienced when carrying out the task,
- Scores in each sub-scale from the Interpersonal Reactivity Index: *Fantasy*, *Empathic Concern, Personal Distress*, and *Perspective Taking*.

The **dependent variables** were the same ones as analysed in the previous section: ratings of most intense induced and perceived affective states (including action tendencies), ratings of core affect, and ratings of the induced and perceived discrete emotions with the highest mean scores.

In order to test the assumption of independence of the covariates and the independent variable, I ran ANOVA tests (and Kruskal-Wallis tests where the normality assumption was not met) with Condition as IV, and the scores of each covariate as DV. As can be seen in Table 7.20, several of these covariates violate the assumption: the ratings of *Difficulty* and *Embarrassment* suggest that the participants in the simulation groups found the experimental task harder and felt more awkward doing it than participants in the other groups. Also, the ratings of *Enjoyment* also suggest that at least in the case of the Sadness/Tenderness piece, the *Vocal Simulation* group found the experience significantly less enjoyable than the other groups.

Since the assumption of independence of the covariates and the independent variable is an interpretational, but not a statistical requirement (Field, 2013, p. 486), I proceeded to carry out the MANCOVA tests, keeping in consideration the identified biases in the results.

Table 7.20 *Results of analysis of the assumption of independence of covariates and independent variables*

Variable	Piece	Significant differences
Enjoyment	Sad Tender	Vocal Simulation < Distracting task (p = .045)
		Vocal Simulation < Motor Simulation group (p = .026)
Difficulty	Sad Tender	Stationary < Motor Simulation (p = .001)
		Stationary < Vocal Simulation (p < .000)
		Distracting Task < Vocal Simulation (p = .003)
	Fear Anger	Stationary < Motor Simulation (p = .001)
	Happy	Distracting Task < Vocal Simulation (p = .013)
Embarrassment	Sad Tender	Stationary < Motor Simulation (p = .002)
		Stationary < Vocal Simulation (p < .000)
		Distracting Task < Vocal Simulation (p = .001)
	Fear Anger	Stationary < Motor Simulation (p < .000)
		Distracting Task < Motor Simulation (p = .010)
		Stationary < Vocal Simulation (p = .019)
	Happy	Stationary < Motor Simulation (p < .000)
		Stationary < Vocal Simulation (p < .000)
Empathic Concern	(NA)	Stationary < Motor Simulation (p = .048)

7.5.6.1 Effect of being able to play an instrument present in the piece:

Hypothesis 1D predicted that the more a participant can play an instrument present in the piece, the more intense his or her affective experience. This prediction was not supported by the data in any of the dependent variables. (See table 7.21 for a summary of the regression analyses). Moreover, the only cases where the MANCOVA tests indicate that this variable explains a significant part of the variance are the ratings of *Most Intense Induced Discrete Emotion* and *Induced Triumph* in the Joy piece, where contrary to the prediction, the Beta coefficients indicate negative correlations between the variables (-.14 and -.21, correspondingly).

The conclusion that being able to play an instrument present in the piece did not make any significant contribution to the results is valid even if the analysis is restricted to the participants in the Motor Simulation group condition, where the effect should have been more marked. Additional evidence for this conclusion is the finding that in the Motor Simulation group, the only significant correlation between participants' reports of *having-the-habit-of-pretending-to-play-the-instruments-they-listen* and the dependent variables is observed in the Sadness/Tenderness piece, where this variable correlates negatively with ratings of *Difficulty* (Rho = -.40, p = .028). Similarly, in the Vocal Simulation group, the participants' ratings of *having-the-habit-of-singing-along-to-music* only correlates significantly with ratings of *Difficulty* in the same piece (Rho = -.55, p = .010).

7.5.7 Effect of Other Covariates on the Participants' Affective Experience

7.5.7.1 Sadness/Tenderness Piece:

While the initial MANCOVA tests indicate the presence of several significant covariates, applying the Benjamini-Hochberg correction makes the p-values nonsignificant, except in the case of ratings of *Enjoyment,* which explained a significant portion of the variance in 9 out of the 19 examined dependent variables: *Most Intense Action Tendency, Most Intense Perceived Discrete Emotion, Induced Soothed, Perceived Peacefulness, Perceived Tenderness, Perceived Spirituality, Valence, Tense Arousal,* and *Energetic Arousal.* All of the regression models for these variables suggest that the more participants enjoyed the piece, the more they experienced these affective states.

Importantly, controlling for the ratings of *Enjoyment* makes the main effect of the independent variable (Listening Condition) nonsignificant for all the dependent variables. In other words, the MANCOVA test yields no significant differences between the groups in any of these measures.

7.5.7.2 Fear/Anger Piece:

The results of the confirmatory MANCOVA test indicate that ratings of *Enjoyment* predict significant portions of the variance in ratings of *Induced Triumphant*, *Admiring*, and *Irritated*, indicating that the more participants enjoyed the piece, the more they felt "triumphant, strong" and "filled with admiration", and the less they enjoyed it, the more they felt "irritated, frustrated".

Ratings of *Difficulty* were also significant covariates for the scores of *Most Intense Action Tendency*: the more difficult the participants found the task, the stronger they felt the subjective feelings and action tendencies described in the questionnaire.

7.5.7.3 Joy piece:

The results of the confirmatory MANCOVA test indicate that the most important covariate was *Enjoyment*, which has significant and positive correlations with all of the evaluated dependent variables. Curiously, in the case of *Perceived Joy,* the regression model also indicates that the more difficult the participants found the experimental task, the more they perceived the piece as expressive of *Joy*.

As mentioned above, the ratings of *Being-able-to-play-an-instrument-present-in-the-piece* were significant and negative predictors of *Most Intense Discrete Emotion* and *Induced Triumphant*, suggesting that the more the participants are able to play an instrument present in the piece, the less strong their induced emotions were, and particularly, their feelings of being “triumphant, strong”.

In summary, the analyses reported in this section indicate that the most important covariate that mediated the results was by far the participants’ rating of enjoyment. Importantly, contrary to what could be expected from previous findings (Vuoskoski *et al.*, 2012), these analyses also indicate that the participants’ scores in the **empathy** trait test (the Interactive Reactivity Index) were not significant predictors for any of the dependent variables. (Table 7.21 summarizes the regression models yielded by all the MANCOVA tests).

Table 7.21 *Summary of regression analyses yielded by the MANCOVA tests*

	Dependent variable	R squared	Significant Predictors	B coef-ficient
Sadness/Tenderness piece	Most Intense Action Tendency	0.20**	Enjoyment	0.22*
	Ind. Soothed	0.24**	Enjoyment	0.54*
	Most Intense Perceived Discrete Emotion	0.17**	Enjoyment	0.15*
	Perceived Peacefulness	0.21**	Enjoyment	0.40*
	Perceived Tenderness	0.18**	Enjoyment	0.29*
	Perceived Spirituality	0.13*	Enjoyment	0.35*
	Ind. Valence	0.32**	Enjoyment	0.76*
	Ind. Tense Arousal	0.26**	Enjoyment	0.64*
	Ind. Energy Arousal	0.10*	Enjoyment	0.41*
Fear/Anger piece	Ind. Triumphant	0.20**	Enjoyment	0.40**
	Ind. Admiring	0.12*	Enjoyment	0.31**
	Ind. Irritated	0.14*	Enjoyment	-0.29*
	Perceived Spirituality	0.14*	Enjoyment	0.35*
	Most Intense Action Tendency	0.08*	Difficulty	0.19*
Joy Piece	Most Intense Action Tendency	0.17**	Enjoyment	0.28*
	Most Intense Perceived Affect	0.14*	Enjoyment	0.24**
	Most Intense Perceived Discrete Emotion	0.19**	Enjoyment	0.38**
	Ind. Happy	0.35**	Enjoyment	0.54*
	Ind. Soothed	0.19**	Enjoyment	0.38*
	Ind. Admiring	0.19**	Enjoyment	0.45*
	Perceived Joy	0.33**	Enjoyment Difficulty	0.48** 0.27**
	Perceived Tenderness	0.13*	Enjoyment	0.32*
	Ind. Valence	0.35**	Enjoyment	0.58*
	Ind. Tense Arousal	0.21**	Enjoyment	0.46*
	Ind. Energy Arousal	0.16*	Enjoyment	0.51*
	Most Intense Induced Discrete Emotion	0.28**	Enjoyment Able play instrument	0.40* -0.14*
	Ind. Triumphant	0.21**	Enjoyment Able play instrument	0.51* -0.21*

*= p<.05, **= p<.001

7.5.8 Effect of Experienced Arousal in the Participants' Affective Experience

The instructions to the participants in the Motor Simulation and Distracting Task conditions required them to make bodily movements, while the instructions to the other two conditions required the participants to stay still. Therefore, it is possible that the participants' different levels of arousal (particularly of energetic arousal) might have influenced their affective experience with the music. Indeed, previous research has found that listeners' arousal while listening to music can have a positive effect on the intensity and valence of the emotions they feel and perceive in music (Dibben, 2004).

I examined this possibility by running Kruskal-Wallis tests with *Tense Arousal* and *Energetic Arousal* scores as dependent variables, and listening condition as independent variable. These tests indicate that there were no systematic differences between the groups in these scores (all p-values > .005). The only exception is the ratings of *Tense Arousal* in the *Joy piece*, where participants in the Vocal Simulation group reported feeling significantly less relaxed than participants in the Distracting Task group H(3) = 11.17 p = .006. These analyses suggest that the above-presented results (such as the higher scores of the Motor Simulation group in several dependent measures), were not due to potential effects of the experimental manipulation on the participants' experienced arousal.

7.5.9 Test of Hypothesis 2: Visual Imagery While Listening to the Music

Hypothesis 2 predicted that the content of the participants' answers to the question: "*what went through your mind while you were listening to the music*" would have the same emotional content as the perceived and induced emotions reported by participants[26]. I analysed the content of each participant's narrative, and created two new categorical variables to indicate whether there was a coincidence between the content of the narrative, and the participant's highest scores of perceived, and induced emotions, correspondingly. I assigned a value of 1 if the content of the narrative matched the highest perceived/ induced emotion, and a value of 0, if they did not.

---

[26] Since this question was formulated at the end of the experiment, in order to facilitate recall, I asked the participants to listen to a fragment of each piece before answering. The majority of the participants had no problem in remembering their thoughts and answering the question.

The hypothesis is supported by the data. As expected from the ambiguous expressive character of the music, in every piece the contents of the participants' narratives can be categorised in terms of two or three emotions with similar levels of arousal, and sometimes of valence. Importantly, on many occasions the correspondence between the perceived emotion and the induced one is not one-to-one, but rather one-to-several. In some cases, they choose highly related adjectives to rate their feelings (e.g. soothed, mellowed, and nostalgic), but on other occasions they choose contrasting ones (e.g. anxious, sad, and triumphant).

In the **Sadness/Tenderness** piece, the overall coincidence rate between the participants' ratings of perceived emotions and their narratives was of 84.68%, and of 79.84% for their ratings of induced emotions. The most frequent themes in the participants' narratives were: images of nostalgia, sadness and romanticism, (several of them mentioned Jane Austen's books, for example), and calm images of spending time in the countryside.

> *"I had a very vivid visual image of revisiting a time in my childhood, I felt transported to a time before my mother died. I am in the garden, playing, exploring the garden.* […] *Even though I could identify the notes and the key, I was concentrated in these images."*
>
> Participant whose highest ratings were perceived Longing = 4, perceived Spirituality = 4, perceived Tenderness = 4, Induced Sad = 4 and Induced Nostalgic = 4
>
> "*I'm on a field with flowers, and the weather is nice. A soothing feeling. Pride & Prejudice* [The movie]"
>
> Participant whose highest ratings were perceived Tenderness= 3, perceived Peacefulness = 3, induced Mellowed = 3, and induced Soothed = 3

In the **Fear /Anger** piece, the correspondence rate between the ratings of perceived emotions and the content of the participants' narratives was of 91.13%, and of 72.58% for the ratings of induced emotions. The participants' narratives usually described imagery related to horror movies (e.g. the suspense of something bad going to happen, or images of being chased by an evil character), and epic scenes of war from movies such as Gladiator, Ben-Hur or Star Wars.

> *"I didn't like it. It was something was trying to chase me, to catch me, to hurt me. I saw the image of a murderer… An episode from The Simpsons, when Bart is going to be killed."*
>
> Participant whose highest ratings were perceived Fear =4,
> and induced Anxious = 4
>
> *"I imagined volcanoes, dramatic scenes on a mountain top, the climax of a fight between superheroes, thunder in the background… A Wagner opera."*
>
> Participant whose highest ratings were
> perceived Pride = 3, and induced Triumphant = 3

In the **Joy piece**, the coincidence rate between the participants' ratings of perceived emotions and their narratives was of 77.42%, and of 69.35% for their ratings of induced emotions. The participants' narratives featured three themes: fantastic characters such as leprechauns, fauns or hobbits merrily dancing; excitement, purposefulness or feelings of determination before an adventure; and medieval scenes of a community of busy people (in a market, for example).

> *The main instrument being played by an animal, a pig, super happy, jumping around, a bit childish and unreal… Fantasia* [the movie], *there's a scene with dancing mushrooms and flowers. Going to carnivals as a little kid.*
>
> Participant whose highest ratings were
> Positive Feelings = 3, and induced Happy = 3

> *It felt quite adventurous, going to an adventure in a positive way. A group of people going out, going hiking. The Hobbit.*
>
> Participant whose highest rating were perceived Positive feelings = 3,
> induced Triumphant = 4, and induced Happy = 3

Interestingly, a few participants (between 4.84% and 7.26%) reported abstract images, ideas or colours, rather than narratives or autobiographical memories while listening to the music:

Calm, bright colours.

Participant whose highest ratings in the Sad /Tender piece were
perceived Longing = 4, perceived Positive Feelings = 4,
induced Mellowed = 4 and induced Soothed = 4

It felt cinematic… Creativity, exploration, adventure, positivity, discovery.

Q/ Were there images in your mind?

A/ No, it was more like ideas, abstract thoughts.

Participant whose highest ratings in the Joy piece were
perceived Joy, induced Mellowed = 3,
induced Happy = 3, and induced Triumphant = 3

Dread, negative emotions, helplessness.

Participant whose highest ratings in the Fear/Anger piece were
perceived Fear =3, perceived pride =3, and induced Anxious = 2

It is important to note that while theories of embodied simulation assume that simulation is an implicit process (Barsalou, 2008), it could nevertheless be speculated that the more embodied simulation is active in a listener' brain, the more he or she should evoke images of the musicians (or themselves) playing the music while listening to it. This type of imagery was present in the data, but it does not represent the majority of cases. In the Sadness/Tenderness piece, it was present in 14.52% of the narratives, in the Fear/Anger piece it was present in 8.87%; and in the Joy piece, it was in 16.13%. Some examples:

The orchestra, their movements, the tension in the orchestra.

Participant whose highest ratings in the Fear/Anger piece were Pride =
3, and induced Triumphant = 3

> *Someone at the piano, and strings players around in a circle, in a practice space.*

Participant whose highest ratings in the Fear/Anger piece were
perceived Longing = 3, Peacefulness = 3, Positive feelings = 3,
and induced Relaxed = 3

> *Cheerful, I imagined myself in a theatre, watching the orchestra playing the tune…* [Also] *A movie of a particular historical period.*

Participant whose highest rating in the Fear/Anger piece were perceived
Joy, induced Mellowed = 4 and induced Happy = 4

Finally, it should be noted that many participants commented that the pieces sounded like they belonged to movie soundtracks, so this might have contributed to evoking images of characters and stories in their minds. These images were not inspired by specific memories from specific movies, but from associations of the music with particular movie genres (horror, romantic movies, adventures, etc.). Indeed, there were low ratings of reported familiarity overall (mean = 0.25 in a scale from 0 to 3), and only one of the participants (out of 124) correctly guessed the movie which one of the pieces belonged to.

7.6 Discussion

This experiment provided the first empirical test of the role of embodied simulation in the phenomenon of emotional contagion with music. The discussion of this first experiment is focused on a methodological interpretation of the results. I elaborate the theoretical interpretation of the findings from this and the second experiment in the final section of the following chapter.

7.6.1 Effect of Embodied Simulation

The first hypothesis of this experiment, based on the BRECVEMA theory (Juslin, 2013b), predicted that the type of simulation involved in emotional contagion with music is an implicit mimicry of the melody. The second hypothesis, based on Scherer's Multifactorial Process Model (Scherer & Coutinho, 2013), predicted that an implicit mimicry of the musicians' gestures triggers the contagion response. Additionally, it was predicted that performing a distracting activity that involved activation of motor and vocal brain areas would obstruct stimulation mechanisms and lead to more subdued affective responses in comparison (Niedenthal *et al.*, 2005).

The results give little support to any of these hypotheses (**hypotheses 1A, 1B and 1C**). There were very few significant differences between the groups, suggesting that the experimental manipulation did not have strong effects on the participants' emotional experience. This was particularly true in the case of the Vocal Simulation group, which in most of the dependent measures displayed an *opposite* trend to the predictions. Likewise, the results do not support the prediction that engaging in a distracting task would have a hampering effect on the participants' affect. Moreover, individual differences in musical skills (such as the ability to play a musical instrument), and in listening habits that involve mimicking the music (such as doing "air-playing" or singing along) did not play a significant mediating role in the dependent measures (**hypothesis 1D**).

Does this mean that the participants' bodily behaviour had nothing to do with their emotional experience? In other words, should these results be taken as supporting a "disembodied" view of musical experiences? Probably not. The responses from the questionnaires reveal for example, that in the Fear/Anger piece the participants in the Stationary condition, (who were asked to remain completely still while listening to this "threatening" music) felt significantly more scared than the participants in the other conditions; and at the same time, the participants in the Motor Simulation condition tended to feel more "triumphant, strong", and to perceive the piece as more expressive of "pride, power" than the rest. Furthermore, the results of the Action Tendencies and Subjective Feelings questionnaire also indicated that the participants experienced several bodily urges while listening to the music.

How to account for the observed null results? A number of explanations can be proposed. The first and simplest interpretation, is that the experimental tasks did not create the intended conditions. The tasks were undeniably difficult, particularly in the simulation conditions: even though the participants had the chance to listen to the piece twice, it is still difficult to follow a piece of music and to pretend to play it, or to sing along to it if one has never heard it before. Furthermore, perhaps singing along with the music prevented the participants in the Vocal Simulation group from actually hearing the piece very well. Indeed, in spite of the fact that the regression analyses did not indicate that ratings of difficulty or embarrassment were significant predictors of most of the dependent measures, the spontaneous comments of several participants suggest that they found the tasks too demanding (e.g. "*I found it hard to hum along*"… "*I wasn't sure of which instrument to mimic*"), embarrassing (e.g. "*I felt self-conscious of the humming*") or even tedious (e.g. "*I found the* [counting cubes] *task pointless and boring*"). Thus, it can be speculated that these experiences of difficulty, embarrassment, and boredom prevented the experimental manipulation to have full effect (see Table 7.20).

Second, in the case of the Distracting Task group, which did not exhibit the expected hampering effect, it is possible to speculate that the participants in this condition somehow entrained their movements to the music, and therefore the task facilitated their emotional engagement with the pieces, rather than prevented it.

A third, more optimistic interpretation is that at least in the case of the Motor Simulation condition, the null results were due to lack of statistical power. The participants in this group displayed the predicted trend in 52% of the evaluated variables, suggesting that pretending to play the musical instruments that we listen to has a positive effect on the intensity of our emotional responses, but that this effect is very small, and therefore the statistical tests did not detect it.

A fourth interpretation of the null results is that embodied simulation is a necessary, but not sufficient condition for the perception and induction of musical emotions. That is, even though it is probable that perceiving sounds as "music" involves embodied simulation mechanisms, the effects of this internal mimicry are restricted to facilitating the *perceptual* experience of sounds as organised, intentional, humanly-produced musical sounds (Launay, 2015; Leman & Maes, 2014). These effects however, do not extend to producing affective responses to the music. Consequently, emotional responses to music would only happen when these (implicitly or explicitly) mimicked physical gestures and sounds have some sort of *emotional connotation* or *emotional relevance* for the listener. The second experiment in this study (reported in the next chapter) explores this possibility.

7.6.2 Effect of Visual Imagery

The null effects of the experimental manipulation, along with an analysis of the answers of the participants to the question "*what went through your mind while listening to the music?"* suggest that semantic associations played a determinant role in the emotional experiences of the participants. This analysis shows that even the participants in the simulation conditions, who were actively mimicking the music, evoked images and narratives, instead of imagining the musicians playing the music (as could perhaps be expected from the fact that they were engaged in a sort of imitation of the musicians). Moreover, those narratives and images usually resembled, or were associated with movie genres, or with particular films or TV dramas. While this could be due to the fact that in effect, the stimuli were taken from movie soundtracks, other research has found that cinematic references are a common way in which people report their experiences with music (e.g. Dibben & Herbert, in press; Tagg & Clarida, 2003). This tendency to associate music with movie soundtracks might be due to the fact that in our contemporary societies, acousmatic listening in multimedia contexts has become the default way of experiencing music. Thus, it would not be surprising to find that this aspect of people's subjective experience with music should take precedence over the simulation of the gestures necessary to perform it, or of the melody of the piece.

In summary, the analyses of the participants' answers largely support **hypothesis 2**, which predicted a correspondence between the contents of the participants' narratives and their scores in the questionnaires of perceived and induced emotions. However, my claim is not that the narratives and imagery evoked by the participants *caused* the reported perceived and induced emotions. Instead, based on the assumption that having an emotion involves representing a personally-relevant situation in multiple modes at the same time –physiological, cognitive, motivational, and experiential- (Clore & Ortony, 2013), my interpretation is that these narratives and imagery were *components* of the participants' emotional reactions, not their primary cause. Furthermore, since I did not manipulate the participants' imagery and associations with the music, it is impossible to determine whether the narratives and imagery produced the observed emotional responses, or the aroused emotional states triggered the evoked narratives and imagery.

My claim is rather that both the participants' emotional responses, and the narratives and imagery they evoked, were at least partially caused by another underlying mechanism: the *activation of semantic knowledge* while listening to the music. Support for this interpretation can be found in the observation that about 25% of the participants did not include any emotional terms or connotations in their answers to the above-mentioned open question, but they still chose the same emotional adjectives in the questionnaires as those participants who used this kind of terms in their answers. The second experiment from this study (reported in the next chapter) tests this alternative explanation by asking the participants to read narratives about the musical pieces before listening to them.

7.6.3 The Potential Mediating Role of Empathy

The mediation analyses showed that enjoyment was the main covariate in the observed results. This variable predicted the induction of positive emotions when the participants liked the music, and the induction of negative emotions when the participants disliked it. This effect was more marked in the case of the Fear/Anger piece, where disliking or liking the music made the difference between feeling “anxious” or “irritated” vs. feeling “strong”, “proud”, or “triumphant”, which are probably better adjectives to describe pleasant reactions to this type of music than the traditional dichotomy scared / angry.

The implication of this mediation role of enjoyment is that what we call “emotional contagion” does not correspond to mere mimicry, but to a more complex phenomenon that is mediated by factors such as aesthetic appraisals of the musical sounds. This observation parallels the conclusions of Hess & Fischer (2013, 2014) who have found that emotional mimicry and contagion are mediated by social affiliation considerations, such as the extent to which we like the person we observe. Hence, it can be speculated that a similar dynamic occurred in this experiment: perhaps at some level, the participants experienced the musical sounds as specifying a more or less abstract “social other” (Cochrane, 2010b; Launay, 2015), or perhaps the musical sounds simply evoked social affiliation connotations (e.g. “this sounds like the kind of music that people like me enjoy listening to”). In either case, the consequence of this social dimension of the experience with music is that the participants could only become *infected* by the emotion expressed by these virtual “social others” if they liked them, or if they perceived them as belonging to the same in-group. An interesting implication of this rationale is that musical emotional contagion could be better characterised as “empathy” rather than as mere “contagion”. A similar proposal has been recently made by Clarke, Vuoskoski and De Nora (Clarke, DeNora, & Vuoskoski, 2015), who suggest that rather than involving mimicry of expressive gestures, musical emotional contagion should be described as the “mirroring of contextualized emotions” (p. 9). This possibility is explored in experiment 2, reported in the next chapter.

8. The role of embodied simulation in emotional contagion with music, experiment 2: Simulation, extra-musical information and empathy

This experiment has three aims: first, it represents a further attempt to test the hypothesis that embodied simulation facilitates the perception and induction of musical emotions. Second, it examines the role that the activation of semantic information has in determining the type of perceived and induced emotions that listeners experience. Third, it explores the possibility that empathic responses are involved in the so-called “emotional contagion” with music phenomenon.

8.1 New methodological strategy

One of the main results of the experiment reported in the previous chapter (henceforth referred to as “experiment 1”) was that the participants in the Motor Simulation condition displayed the predicted trend in more than 50% of the dependent measures. This suggests that the null results might have been due to a combination of lack of statistical power (due to an insufficiently large sample size), and the difficulty and embarrassment that the participants in this condition experienced while performing the experimental task. With this in mind, I decided to carry out the present follow-up experiment focused on motor simulation, and to design it as a web-based experiment.

Web-based experiments have been recently implemented in music and emotion studies successfully (e.g. Egermann, Nagel, Altenmüller, & Kopiez, 2009; Tesoriero & Rickard, 2012; Witek, Clarke, Wallentin, Kringelbach, & Vuust, 2014). This method has the advantage of allowing for the quick collection of data from large samples, reducing researcher bias, and crucially, eliminating the potentially embarrassing or distracting presence of the experimenter. They also have several disadvantages, such as a lessening of experimental control, dropout of participants, and variability in the listening devices used by the participants doing the experiment (Egermann *et al.*, 2009). The strategies implemented in the present study to overcome these difficulties are explained in the Methods section.

Furthermore, an additional measure was adopted to counter the negative effect of the difficulty of the task. In this experiment, instead of asking the participants to pretend to play the musical instruments they hear by doing "air-playing", or to engage in a distracting motor task, the participants were asked to only *imagine* themselves either as musicians playing the instruments, or as sound engineers evaluating the quality of the recording (a task designed to prevent the participants from simulating). The decision to use this methodological strategy is validated by findings from neuroimaging studies, which have concluded that imagining and planning motor actions activates the same brain areas as actually performing the movements both in everyday tasks (Jeannerod, 1995; Jeannerod & Frak, 1999), and in musical ones (Bangert *et al.*, 2006; Zatorre & Halpern, 2005).

As in experiment 1, the first **hypothesis** of this study is that, compared to the participants who will perform the distracting task, the participants in the simulation condition will experience more intense perceived and induced emotions while listening to the music. Likewise, it is expected that this effect will be moderated by musical expertise, that is, those participants who can play an instrument present in the musical piece will experience more intense emotions than those who cannot (**hypothesis 2**).

8.2 Revised hypotheses I: semantic associations

The results from experiment 1 suggested that even though the material properties of the music were the main factor that drove the participants' emotional experiences, this factor by itself could not explain all the observed variation in the data. Hence, I speculated that this variation could be at least partially accounted for by the activation of semantic concepts, which worked as internal "contexts" biasing the participants' perception of emotions expressed by the music, and the type of emotions aroused in themselves.

Constructionist theories of emotion such as Russell's (2003) and Barrett's (2006b) emphasise the central role that situational and internal contexts play in emotional experiences. Unlike Basic Emotion theories, which explain emotions as resulting from activation of innate affective programs (Ekman, 1992; Panksepp, 2000), and unlike Appraisal theories, which emphasize explain emotions as driven by the evaluation of a new stimulus (Scherer, 2009a; Smith & Ellsworth, 1985), psychological constructionist theories propose that emotions emerge from the interaction of primitive psychological processes and the personal and situational context of the individual.

Recently, Vuoskoski and Eerola carried out an experiment more directly aimed at testing the influence of extra-musical information on *induced* musical emotions (Vuoskoski & Eerola, 2013). They asked participants to listen to a piece of music that conveys sadness, after having read a sad narrative, a neutral narrative, or not having read any description. They found that compared to the other groups, participants who read the sad narrative showed more signs of induced sadness, and that the content of the descriptions about what they thought while listening to the music contained more sad imagery. The authors interpreted these results as stemming from the activation of the visual imagery mechanism proposed in the BRECVEMA theory (Juslin & Västfjäll, 2008).

The results of experiment 1 also showed that in the majority of cases, participants evoked mental visual images while listening to the music. However, unlike Vuoskoski and Eerola's (2013), I suggested that this phenomenon was secondary to the activation of the activation of semantic knowledge while listening to the music. In other words, the musical sounds activated relevant cultural knowledge about the music's meanings and uses in contexts such as film soundtracks, and this in turn, triggered the construction of visual imagery and narratives in the participants' minds.

The present experiment aims to continue exploring the validity of this interpretation by testing the effect of actively manipulating information about the pieces. Thus, following a similar procedure to that used by Vuoskoski and Eerola (2013), before listening to each piece, the participants will read a description that I predict will bias their perceived and aroused emotions in a coherent manner (**Hypothesis 3**). However, unlike their experiment, this study will test this effect in pieces expressive of three types of emotions: fear and joy in addition to sadness. Also, this experiment will compare the effect of a neutral description versus the effect of two alternative emotional ones. In other words, some participants will read a description of the music emphasising emotionally neutral technical characteristics, and other participants will read a description which suggests that the composer wrote the music inspired either by an emotion A, or by an emotion B.

The fourth hypothesis is based on the argument that the results from experiment 1 were in part due to fact that the mimicked gestures performed by the participants lacked an emotional connotation for the listeners. Thus, it is predicted that the two main independent variables in this experiment will produce an interaction: those participants who perform the simulation task and read the emotional descriptions of the pieces will experience more intense emotions than those participants who perform the non-simulation task and who read the neutral descriptions (**Hypothesis 4**).

8.3 Revised hypotheses II: empathy

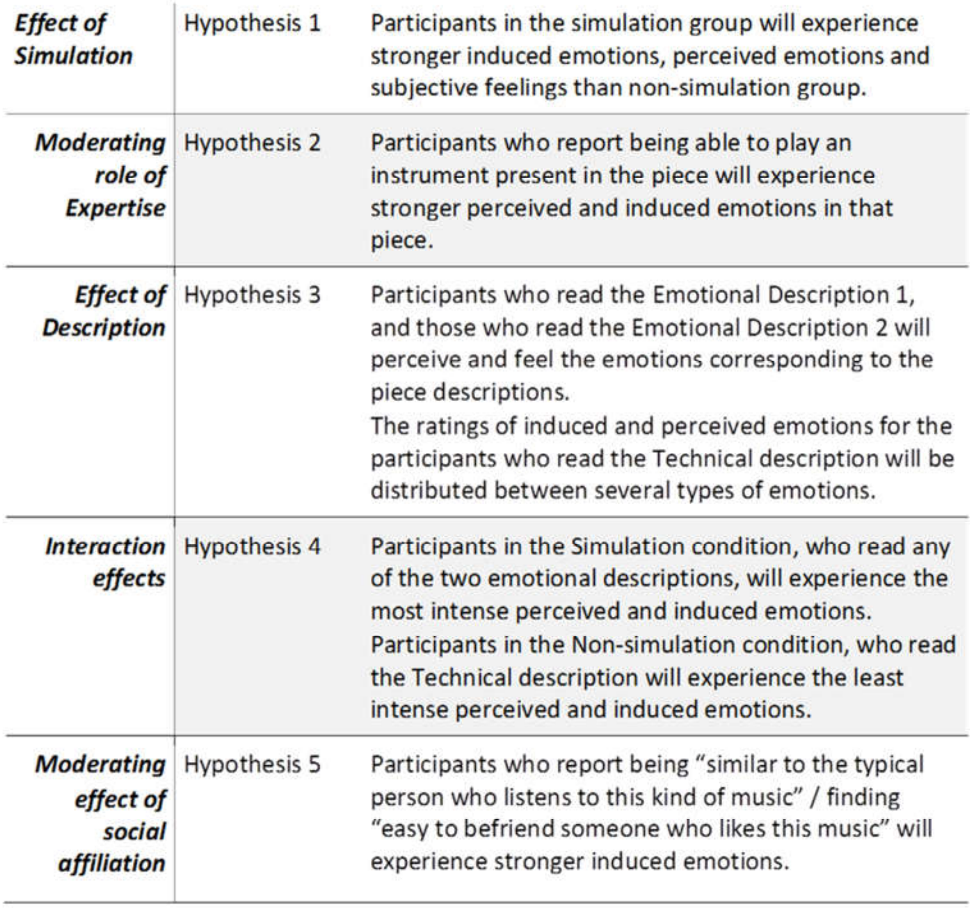
The results of Experiment 1 suggested the possibility that what researchers call "emotional contagion" with music is actually a type of empathy. Recent findings suggest that in cases where people seem to "automatically" become infected by the mere observation of another's emotional expressions, are actually moderated by evaluations of social affiliation. For example, observers are more likely to become to sympathise with someone else if the observed individual belongs to their same social group (Bourgeois & Hess, 2008; Gutsell & Inzlicht, 2010), or if they perceive the observed individual as a fair player in a competition game (Singer *et al.*, 2006).

In the case of music, several recent theories and empirical studies suggest that implicit and explicit empathic attitudes moderate emotional experiences with music. Vuoskoski and colleagues found that trait empathy moderates the enjoyment and intensity of emotional responses evoked by sad-sounding music (Vuoskoski *et al.*, 2012). Similarly, Wöllner (2012) found that participants with higher levels of the affective component of the empathy trait were better at identifying the moments where the members of a string quartet played more expressively in visual-only, and audiovisual versions of a performance (but not in the auditory only version). Scherer and Coutinho have proposed that empathy towards the musicians constitutes a route to the induction of emotions, particularly in live performances and social listening contexts, where the listeners would imagine the feelings and motivations of the observed performers, and feel compassion as a consequence (Scherer & Coutinho, 2013, p. 139). Support for this hypothesis can be found in Miu and Balteş' study (2012) where the researchers manipulated the attitude of the participants (empathic vs objective) while watching audiovisual extracts of opera performances. They found that those participants who adopted an empathic attitude had more intense physiological responses and induced emotions, which matched the emotions expressed by the music and the performer's gestures. Finally, using a web-based methodology, and audio-only stimuli, Egermann and McAdams (Egermann & McAdams, 2013) found that participants' ratings of the extent to which they "empathised with the musicians [they] just heard" (p. 144) positively predicted the coincidence between ratings of perceived and induced valence and arousal.

Based on these theories and findings I speculate that if we adopt a broad definition of empathy (e.g. Clarke, DeNora, & Vuoskoski, 2015; Preston & de Waal, 2002), then the results of Experiment 1 should be regarded as instances of empathy, and not of mere contagion. If we assume a more narrow definition of empathy instead (e.g. Coplan, 2011; de Vignemont & Singer, 2006), then we can only consider an instance of emotional contagion as an instance of empathy, if the person becoming infected by the observed emotion realizes that the feelings he or she is experiencing belong to someone else originally.

Since experiment 1 did not provide data to decide between these two possibilities, the last aim of this experiment is to test them. For this, after each trial, the participants were asked to answer two questions evaluating the extent to which the music they just listened to evoked social affiliations. Hence, it is expected that the more the participants report that the music evoked positive feelings of social affiliation, the more intense their emotional reactions will be (**Hypothesis 5**). Moreover, I will analyse the participants' answers to the question about what they thought while listening to the music, in order to observe if they explicitly mention that the music communicated the composer's feelings. If this is the case, then it will be taken as evidence that the participants underwent an experience of "empathy", as defined by Coplan (2011) and de Vignemont & Singer (2006).

Table 8.1 *Summary of experimental hypotheses*



Effect of Simulation	Hypothesis 1	Participants in the simulation group will experience stronger induced emotions, perceived emotions and subjective feelings than non-simulation group.
Moderating role of Expertise	Hypothesis 2	Participants who report being able to play an instrument present in the piece will experience stronger perceived and induced emotions in that piece.
Effect of Description	Hypothesis 3	Participants who read the Emotional Description 1, and those who read the Emotional Description 2 will perceive and feel the emotions corresponding to the piece descriptions. The ratings of induced and perceived emotions for the participants who read the Technical description will be distributed between several types of emotions.
Interaction effects	Hypothesis 4	Participants in the Simulation condition, who read any of the two emotional descriptions, will experience the most intense perceived and induced emotions. Participants in the Non-simulation condition, who read the Technical description will experience the least intense perceived and induced emotions.
Moderating effect of social affiliation	Hypothesis 5	Participants who report being "similar to the typical person who listens to this kind of music" / finding "easy to befriend someone who likes this music" will experience stronger induced emotions.

8.4 Method

8.4.1 Participants

The experiment was carried out as a web-based experiment. Participants were recruited by personal invitation via e-mail, by snowballing sampling, and by links to the study from several social media websites and mailing lists (Twitter, Facebook, Reddit, auditory.org, musicology.org). All participants could take part in prize draw to win one £30 Amazon voucher.

The first page of the website asked them to choose the "language that they understood better" (English or Spanish), and to indicate their month of birth. Participants were allocated to the corresponding version of the questionnaire according to their language, and to the 6 different conditions and counterbalancing groups according to their month of birth.[27]

A total of 447 people took part, but almost half of them were excluded from the analysis, due to the measures I took control for due commitment to the experiment. The first measure consisted in asking the participants four questions about the level of difficulty and concentration they experienced after each trial:

a) My attention was focused entirely on the listening task, I forgot about everything else while listening to the music.

b) I was interrupted and distracted by other things while listening to the music.

c) I was able to avoid moving, tapping, dancing or singing while listening to the music.

d) I found it difficult to imagine myself… playing the instruments I listened to / as a sound engineer evaluating the quality of the recording.

I calculated a compound score by adding the scores from items *a* and *c*, and subtracting the scores from items *b* and *d* (Mean = 4.36, SD=2.09). I excluded those participants whose compound scores of were lower than 4.

The second measure to control for due commitment was to exclude those participants who took too much or too little time doing the experiment, defined as one standard deviation above or below the mean duration (<19 mins or > 42 mins).

As a result from these measures, 212 participants were excluded from the analysis (47% of the initial sample), leaving a final sample of 235 participants. This represents an exclusion rate comparable to other web experiments (Egermann, Nagel, *et al.*, 2009). The participants included in the analysis had a mean age of 28.8 years (SD = 9.43); (58.7% Female, 40.4 Male, 0.9% chose not to state their gender). They had 26 different mother tongues, but most of them had either Spanish (47.23%) or English (28.09%) as their first language. Similarly, although participants came from 42 different nationalities, more than half were either from Colombia (32.77%), or the United Kingdom (21.28%). The English version was completed by 128 participants (54.5%) and the Spanish version by 107 (45.5%).

---

[27] In order to guarantee that the Spanish version was a faithful translation of the English version, a bilingual native Spanish person was asked to translate the English version into Spanish; then the experimenter and the translator versions were compared, and any differences were discussed and agreed upon.

As mentioned above, the participants were allocated to the experimental conditions based on their month of birth. This strategy resulted in a fairly even distribution of the groups, as shown in table 8.2.

Table 8.2 *Distribution of participants into experimental groups*

IV1: Simulation	IV2: Description of the piece	Counter-balancing group	Month of birth	Participants per group		
Simulation	Emotional description 1	1	January	20	31	129
		2	February	11		
	Emotional description 2	3	March	27	50	
		4	April	23		
	Technical description	5	May	19	48	
		6	June	29		
Non-Simulation	Emotional description 1	1	July	17	39	106
		2	August	22		
	Emotional description 2	3	September	27	37	
		4	October	10		
	Technical description	5	November	15	30	
		6	December	15		

8.4.2 Musicianship

I measured the participants' musical engagement and training with 8 items. The results suggest that the participants had a rather high level of musical engagement, and of musical training:

- 45.1% of the participants reported listening to music at least 1 hour per day.
- 67.7% agreed to some extent with the statement: "I spend a lot of my free time doing music-related activities".
- 75.7% agreed to some extent with the statement: "Music is kind of an addiction for me - I couldn't live without it".
- 46.8% disagreed to some extent with the statement: "I would not consider myself a musician".
- 70.2% disagreed to some extent with the statement "I have never been complimented for my talents as a musical performer".

- 51.9% of the participants have received at least 3 years of musical training.
- 78.7% of the participants reported being able to play at least one musical instrument to some level of ability.

8.4.3 Design

The experiment used a between-subjects design, with two independent variables: *Simulation* (two levels: *Simulation*, *Non-Simulation*), Type of Description of the piece (three levels: Emotional description 1, Emotional description 2, Neutral description); and *Perceived* and *Induced affective states* as dependent variables.

8.4.4 Musical Stimuli and Descriptions of the Pieces

The musical stimuli consisted of the same three instrumental pieces used in experiment 1, but in this experiment their duration was shorter (around 60 seconds), in order to prevent dropout of participants due to boredom[28]. As in experiment 1, the pieces were edited so that every participant would listen to them twice in a row.

Based on the imagery and narratives that the participants spontaneously evoked while listening to the music in experiment 1, I created three types of descriptions for each piece: two descriptions suggesting that the piece was composed during an emotionally-important episode of the composer's life, and one describing the piece in neutral, technical terms. In each piece, the two emotional descriptions can be mapped onto the same areas of the two-dimensional space (arousal vs. valence) (Russell & Barrett, 1999).

The two emotional descriptions of the first piece ("Kip's lights" from the movie *The English Patient*), suggested that the feelings of the composer at the moment of writing the music were either of sadness, or tenderness:

Sadness description: The composer wrote this piece towards the middle of his career, in what proved to be one of the most difficult years of his life. His young wife died while giving birth to their first child, and a few months later he had to leave his

---

[28] Even though the pieces are the same as in experiment 1, due to the content of the descriptions that the participants read, in this experiment I call the second and third pieces with slightly different names: "Fear/Pride" (instead of "Fear/Anger") and "Joy/Determination" (instead of Joy).

position as lecturer of composition in a prestigious university and travel to a different country as a political refugee, because the start of war in his home country made the political climate too dangerous to remain there.

Tenderness description: The composer wrote this piece towards the middle of his career, in what proved to be one of the most productive years of his life. He was appointed as lecturer of composition in a prestigious university, and a few months later, his wife gave birth to their first son. The composer wrote this piece during the spring of that year, when he moved with his new family to a country house to spend as much time as possible with their new-born child.

Technical description: You will now listen to a short extract from a piece from the end of the last century. The piece is an adagio, characterized by a simple melody and a slow accompaniment.

The emotional descriptions of the second piece ("Max" from the movie "*Cape Fear*"), suggested that the composer wrote the piece of music intending to communicate feelings of either pride or of fear:

Pride description: The composer wrote this piece to commemorate the tenth anniversary of the victory of his country against an invading army. He took inspiration from his memories of the bravery and sacrifice that his countrymen displayed during the decisive battle.

Fear description: The composer wrote this music to commemorate the difficult times that his country lived during the war. He was inspired by his childhood memories of having his sleep interrupted by the sounds of the enemy's airplanes dropping the bombs that destroyed large parts of his home town.

Technical description: You will now listen to an extract from a 20th century symphony. It is characterized by the alternation of loud and descending sounds with quieter and ascending ones.

In the third piece ("Oliver learns the hard way" from the movie "*Oliver Twist*"), the emotional descriptions suggested that the composer intended to portray feelings of either joy or determination:

Joy description: The composer wrote this piece for the scene of a ballet that portrays folk traditions in his home country. Inspired by traditional tales, he wrote this piece for a scene full of fantastic animals dancing in the woods.

Determination description: Inspired by fantastic novels, the composer wrote this musical piece for the scene of a ballet in which the bold characters prepare to embark on the epic adventure that will be portrayed during the rest of the work.

Technical description: This piece of music has a moderate speed and a syncopated rhythm, and features a simple and repetitive melody.

8.4.5 Measures

The participants' affective experience was measured the same set of questionnaires used in experiment 1: the action tendencies and subjective states questionnaire, the questionnaire of induced emotions and core affect, and the questionnaire of perception of emotions expressed by the music. They were also asked to report their liking, and their familiarity with the piece, and how difficult they found it to concentrate and follow the experimental instructions (as described in the section 8.4.1 above). In order to explore if the pieces evoked any feelings of social affiliation, the participants were asked to answer these two questions, using a 5-point Likert scale ranging from "not at all" to "very much":

- How much do you consider yourself to be similar to the typical person who enjoys this kind of music?
- Do you think you it would easy for you to befriend someone who loves this kind of music?

Additionally, after each trial, the participants were asked to write down a brief summary of what went through their minds while listening to the music. At the end of the experiment the participants filled in the questionnaire about their demographic information, musical engagement and training, and the musical instruments they could play.

8.4.6 Procedure

The experimental procedure comprised eight sections (see Figure 8.1) that altogether took on average 29.21 minutes to complete (SD = 5.54).

The experiment started by asking the participant to select their preferred language and to indicate their month of birth. According to their answer to these questions, they were assigned to their corresponding version of the procedure. Then they read the instructions for the procedure, emphasizing the need to make it in a noiseless environment, without interruptions, and listening to the music through headphones. Subsequently, they did a practice trial to familiarize themselves with the mental task, with the interface that played the music, and to adjust the volume. After this, they started the main section of the experiment. In this section they read the description of the piece, then they listened to it while performing the assigned mental task, and then they answered to the questionnaires about their listening experience. Finally, after having completing the main section with the three pieces, they answered the demographic and musicianship questionnaires. (A copy all the texts and questionnaires can be found in Appendix 3).

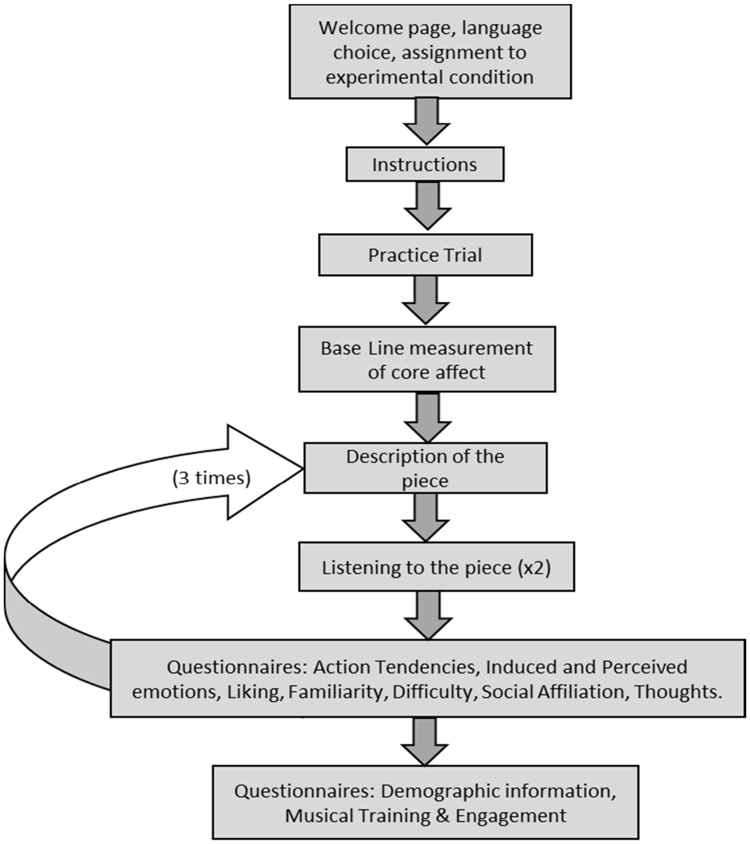


Figure 8.1 Flowchart of procedure.

The instructions for the participants in the **Simulation** condition were the following:

> *Please listen to the piece while imagining that you are one of the musicians playing the music. (You can choose to imagine playing only one of the instruments, or if you prefer, you can imagine switching from one instrument to the other as the music progresses). Please avoid moving, tapping, dancing or singing while listening to the music.*[29]

The instructions for the participants in the **Non-Simulation** condition were:

> *Please listen to the piece while imagining that you are a sound engineer, who is in charge of checking that the recording does not contain any glitches or errors, before it is copied to a CD. Please avoid moving, tapping, dancing or singing while listening to the music.*

As in experiment 1, the practice trial consisted in listening to a fragment of Satie's Gymnopedie No.1 twice (total duration = 82 seconds) and asking two questions to make sure the participants understood the difference between *perceived* and *induced* emotions.

8.5 Results

The presentation of the results is organized as follows:

1) The manipulation check, analysing the extent to which the stimuli elicited the target emotions, and the correlation analyses of perceived vs. induced emotions.
2) The results of the test of main hypotheses: interaction effects, main effect of simulation, main effect of description.
3) The analyses of the moderating role of covariates on the dependent measures, including the effect of expertise, and social affiliation attitudes evoked by the music.
4) The analysis of the qualitative data gathered from the question: "what went through your mind while listening to the music?"

---

[29] The instruction of not singing along aimed at preventing the activation of vocal simulation mechanisms, and the instruction of not moving, tapping or dancing aimed at preventing the activation of the rhythmic entrainment mechanism.

8.5.1 Manipulation Check I: Did the Stimuli Elicit the Target Emotions and Subjective Feelings?

The analysis of the participants’ answers to the questionnaires indicates that the musical pieces elicited the intended perceived and induced emotions.

The induced emotions in the **Sadness/Tenderness** piece with the highest mean scores (above 1.0) in the Sad/Tender piece were, in descending order: *Mellowed*, *Nostalgic*, *Inspired* (transcendent), *Admiring*, *Happy* and *Sad*. The perceived emotions with the highest means scores were: *Longing, Tenderness, Spirituality* (otherworldliness) and *Melancholy*. (See table 11.1 in Appendix 4 for means and standard deviations).

In the **Fear/Pride** piece, the induced emotions with the highest mean ratings were: *Anxious*, *Irritated*, *Triumphant*, *Sad*, and *Admiring*. The perceived emotions with the highest mean ratings in this piece were: *Fear, Anger*, *Pride/power*, and *Melancholy/ Misery*. (See table 11.3 in Appendix 4 for means and standard deviations).

The emotions with the highest mean ratings in the **Joy/Determination** piece were: *Happy, Triumphant, Admiring, Transcendent*, and *Mellowed.* The perceived affective states with highest mean ratings were Joy, *Pride*, *Tenderness*, and *Spirituality*. (See table 11.5 in Appendix 4 for means and standard deviations).

8.5.2 Manipulation Check II: Did Reports of Perceived and Induced Emotions Correlate?

As in experiment 1, the assumption that the participants experienced “emotional contagion” implies the existence of high and significant correlations between the emotions they perceived and the corresponding induced emotions. This assumption is largely met by the data: overall, the Spearman correlations coefficients range from .20 to .67 (median = .49, all p-values < .005). Tables 11.7, 11.8 and 11.9 in Appendix 4 display the summaries of these correlation analyses.

8.5.3 Hypotheses testing

The descriptive analyses of the dependent variables showed that none of them is normally distributed. However, given the large size of the sample, it can be assumed that these characteristics are unlikely to be due to errors in sampling. At the same time, the variables do not display the same degree or type of skewness; therefore applying a data transformation to all the data does not seem to be a viable alternative. Given the fact that ANOVA is a robust test when the normality assumption is not met (Finch, 2005), and since there are not non-parametric alternatives to 2-way ANOVA, I decided to run 2-Way Factorial ANOVA tests to analyse the data.

8.5.4 Interaction Effects

Hypothesis 3 predicted that participants in the Simulation condition who read an emotional description would experience higher perceived and induced affective states than participants in the Non-Simulation condition who read the technical description. The MANOVA test indicates that no interactions between the two independent variables (simulation and type of description) were statistically significant. It also reveals that there were no significant differences in the intensity of the participants' emotional reactions to the music as a function of whether they read emotional descriptions or technical descriptions of the pieces (all p-values >.005).

From this point on, I examine the main effects of each independent variable separately. However, since it is unlikely that the interaction between the main variables had absolutely no effect on the dependent variables, I used Type III Sum of squares in all the subsequent analyses, a procedure in which the main effects are calculated after accounting for the interaction effects, and which is also more appropriate when the sample sizes for each condition are unequal (Scholer, 2016). Also, all comparisons were adjusted using the Bonferroni procedure.

8.5.5 Main Effect of Simulation

8.5.5.1 Sadness/tenderness piece: most intensely experienced affective states

When examining the most intense affective states, the prediction that the Simulation group would have higher scores than the Non-simulation group (**Hypothesis 1S)** is observed in almost all of the dependent variables, but as can be seen from the effect sizes in Table 8.3, the differences between the groups are too small to be statistically significant, (all p-values > .005).

Table 8.3 *Estimated marginal means, standard errors and ANOVA tests of the most intense affective states as a function of simulation condition in the Sadness / Tenderness piece*

		Mean	SE	95% CI	F (1, 229)	p	*B-H corrected p values*	*Partial Eta Squared*
Most Intense Induced Affect	Non-Simulation	**3.22**	0.09	[3.05, 3.39]	0.07	.799	.801	.00
	Simulation	**3.19**	0.08	[3.04, 3.35]				
Most Intense Induced Discrete Emotion	Non-Simulation	**3.25**	0.08	[3.09, 3.41]	0.06	.801	.801	.00
	Simulation	**3.28**	0.07	[3.13, 3.42]				
Most Intense Action Tendency	Non-Simulation	**3.11**	0.08	[2.96, 3.27]	1.76	.185	.446	.01
	Simulation	**3.26**	0.07	[3.11, 3.40]				
Most Intensely Perceived Affect	Non-Simulation	**2.42**	0.12	[2.18, 2.66]	1.87	.173	.446	.02
	Simulation	**2.65**	0.11	[2.43, 2.87]				
Most Intensely Perceived Discrete Emotion	Non-Simulation	**3.33**	0.08	[3.18, 3.48]	3.48	.064	.446	.01
	Simulation	**3.52**	0.07	[3.38, 3.66]				

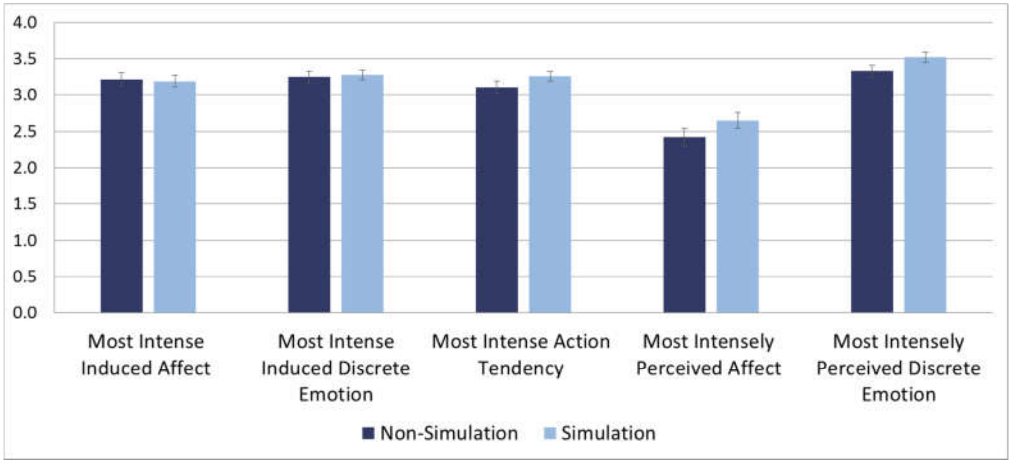


Figure 8.2 Most intense induced and perceived affective states per Simulation condition in Sadness/Tenderness piece

8.5.5.2 Fear / pride piece: most intensely experienced affective states

The Analysis of Variance of the most intense and perceived affective states only shows the trend predicted in **Hypothesis 1** in the scores of *Most Intensely Perceived Affect* and of *Most Intensely Perceived Discrete Emotion.* However, these differences are not statistically significant (all p-values > .005). (Table 8.4 displays the means and the results of the ANOVA test).

Table 8.4 *Estimated marginal means, standard errors and ANOVA tests of the most intense affective states as a function of Simulation Condition in the Fear/ Determination piece*

		Mean	SE	95% CI	F (1, 229)	p	*B-H corrected p values*	*Partial Eta Squared*
Most Intense Induced Affect	Non-Simulation	**2.60**	0.10	[2.99, 0.10]	0.099	.754	.908	.000
	Simulation	**2.58**	0.09	[2.94, 0.09]				
Most Intense Induced Discrete Emotion	Non-Simulation	**2.65**	0.10	[3.04, 0.10]	0.013	.908	.908	.000
	Simulation	**2.65**	0.09	[3.01, 0.09]				
Most Intense Action Tendency	Non-Simulation	**3.00**	0.08	[3.34, 0.08]	0.099	.754	.908	.009
	Simulation	**2.85**	0.08	[3.16, 0.08]				
Most Intensely Perceived Affect	Non-Simulation	**1.66**	0.14	[2.23, 0.14]	1.966	.162	.81	.009
	Simulation	**1.96**	0.13	[2.48, 0.13]				
Most Intensely Perceived Discrete Emotion	Non-Simulation	**3.25**	0.08	[3.55, 0.08]	0.17	.681	.908	.001
	Simulation	**3.31**	0.07	[3.58, 0.07]				

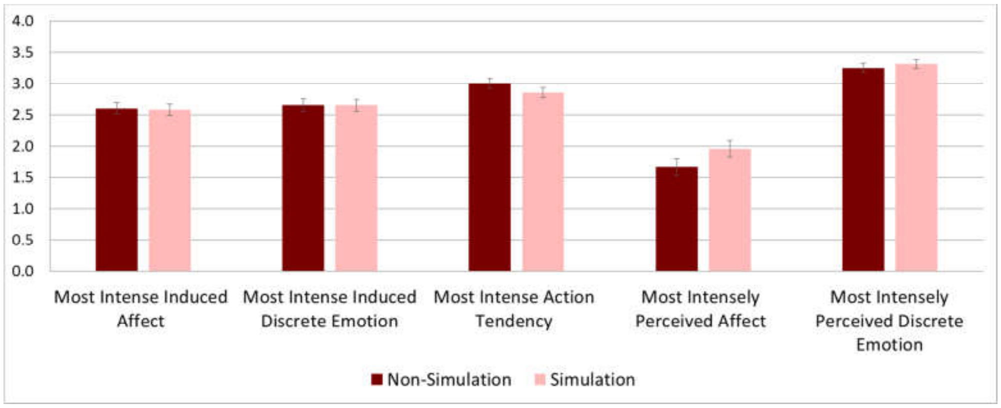


Figure 8.3 Most intense induced and perceived affective states per Simulation condition in Fear/Pride piece

8.5.5.3 Joy / determination piece: most intensely experienced affective states

The trend predicted in Hypothesis 1S is observed in all of the dependent measures: the Simulation group had higher scores than the Non-Simulation group; however, none of the differences between the groups is statistically significant (all p-values >.005). (See Table 8.5 for a summary of the between-subjects tests).

Table 8.5 *Estimated marginal means, standard errors and ANOVA tests of the most intense affective states as a function of Simulation Condition in the Joy / Determination piece*

		Mean	SE	95% CI	F (1, 229)	p	*B-H corrected p values*	*Partial Eta Squared*
Most Intense Induced Affect	Non-Simulation	**3.15**	0.09	[3.33, 0.09]	0.06	.804	.804	.00
	Simulation	**3.18**	0.08	[3.34, 0.08]				
Most Intense Induced Discrete Emotion	Non-Simulation	**3.19**	0.08	[3.35, 0.08]	1.10	.296	.493	.01
	Simulation	**3.31**	0.08	[3.46, 0.08]				
Most Intense Action Tendency	Non-Simulation	**3.28**	0.08	[3.44, 0.08]	0.11	.741	.804	.00
	Simulation	**3.32**	0.07	[3.47, 0.07]				
Most Intensely Perceived Affect	Non-Simulation	**2.89**	0.09	[3.08, 0.09]	3.76	.054	.135	.02
	Simulation	**3.14**	0.09	[3.31, 0.09]				
Most Intensely Perceived Discrete Emotion	Non-Simulation	**3.15**	0.08	[3.31, 0.08]	5.48	.020	.100	.02
	Simulation	**3.41**	0.07	[3.56, 0.07]				

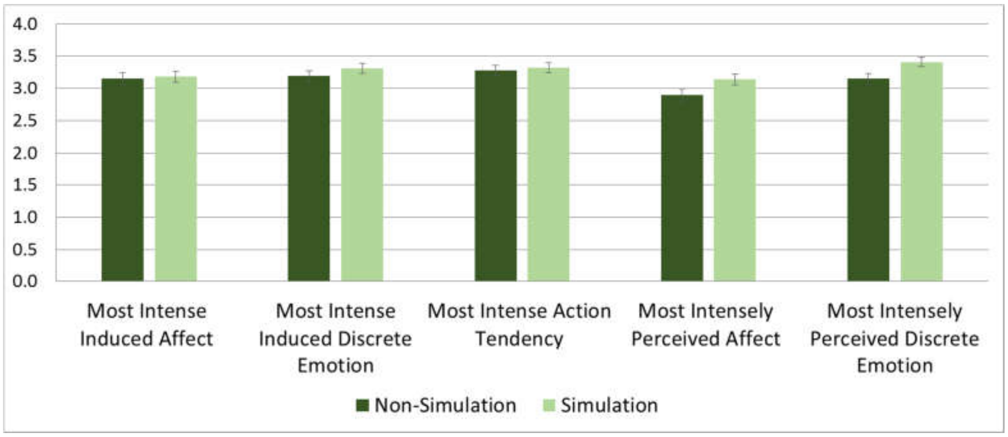


Figure 8.4 Most intense induced and perceived affective states per Simulation condition in Joy/Determination piece

8.5.6 Main Effect of Description

8.5.6.1 Sadness / Tenderness piece: induction and perception of sadness, nostalgia, and tenderness

As predicted in **Hypothesis 2D**, participants who read the Sadness description experienced stronger induced feelings of Sadness than participants who read the Tenderness description F(2, 229) = 10.63 p < .000. Accordingly, the Sadness description group also perceived that the piece expressed Melancholy more intensely than participants who read the Tenderness description F(2, 229) = 18.18 p < .000, and than participants who read the Technical description (p = .033).

Also as predicted, the ratings of Induced Mellowness and of Perceived Tenderness were the highest in the group of participants who read the Tenderness description, but these differences are only significant for Perceived Tenderness F(2, 229) = 28.44 (compared to the Sadness description group, p = .001, and to the Technical description group, p <.000).

Participants who read the Tenderness description also experienced positive subjective feelings and action tendencies more intensely, and negative ones less intensely than participants who read the other two descriptions. Their scores of Feeling-in-command-of-the-situation F(2,234) = 9.51 were higher compared to the Sadness description group (p = .002) and to the Technical description group p < .000; they had higher scores of Feeling-like-everything-is-fine F(2,234) = 20.25 than the Sadness description group (p <.000); and than the Technical description group (p = .001). The group who read the Tenderness description also had lower scores of Needing-to-be-comforted F(2,234) = 4.85 than the Sadness description group (p = .015), and than the Technical description group (p = .048). Contrary to the prediction, participants who read the Sadness description did not report higher scores of Feeling-Like-Crying than participants who read any of the other two descriptions.

An examination of other induced and perceived discrete emotions more highly rated by the participants shows a trend which is consistent with the hypothesis. Participants who read the Tenderness description reported higher ratings of Induced Happiness F(2, 229) = 18.19 and of Perceived Joy, F(2, 229) = 27.27 than participants who read the other two descriptions (p < .000 in all comparisons). Accordingly, participants who read the Sadness description had slightly lower scores of Induced Valence than participants who read the Tenderness description F(2, 229) = 4.45 p = .064; and these participants in turn had significantly higher scores than participants who read the Technical description, who had the lowest scores of all (p = .020).

Even though the participants’ ratings of Perceived Longing were significantly higher for the group who read the Sadness description than for those who read the Tenderness description F(2,229) = 7.68 p < .000; there were no significant differences between the groups in their ratings of Induced Nostalgia. There were not any other significant differences between the groups for the resting scores of induced and perceived emotions.

(Table 8.6 displays the marginal estimated means and the results of the ANOVA tests for all the results described above).

Table 8.6 *Estimated marginal means, standard errors and ANOVA tests of discrete emotions as a function of Description Condition in the Sadness/Tenderness piece*

	Type of Description	Mean	**Std. Error**	**95% CI**	**F (2, 229)**	**p**	η^2	**Sig.**
Induced Sad	1 Sadness	**1.30**	0.13	[1.05,1.55]	10.63	**.000**	.09	1 > 2 ** 2 > 3**
	2 Tenderness	**0.59**	0.11	[0.37,0.81]				
	3 Technical	**1.18**	0.12	[0.94,1.42]				
Induced Mellowed	1 Sadness	**2.27**	0.15	[1.97,2.57]	0.68	.506	.01	(none)
	2 Tenderness	**2.5**	0.14	[2.23,2.77]				
	3 Technical	**2.34**	0.15	[2.04, 2.63]				
Induced Nostalgic	1 Sadness	**2.13**	0.16	[1.81, 2.45]	0.01	.986	>.000	(none)
	2 Tenderness	**2.11**	0.15	[1.83, 2.4]				
	3 Technical	**2.09**	0.16	[1.78, 2.4]				
Induced Happy	1 Sadness	**0.86**	0.13	[0.60, 1.11]	18.18	**.000**	.14	2 > 1** 2 > 3** 2 > 3**
	2 Tenderness	**1.86**	0.12	[1.63, 2.09]				
	3 Technical	**1.12**	0.13	[0.87, 1.37]				
Perceived Melancholy	1 Sadness	**2.12**	0.14	[1.84, 2.40]	28.44	**.000**	.20	1 > 2** 1 > 3* 2 > 3*
	2 Tenderness	**0.72**	0.13	[0.46, 0.97]				
	3 Technical	**1.62**	0.14	[1.35, 1.89]				
Perceived Tenderness	1 Sadness	**2.58**	0.13	[2.32, 2.83]	9.62	**.000**	.10	2 > 1** 2 > 3**
	2 Tenderness	**3.19**	0.12	[2.96, 3.42]				
	3 Technical	**2.53**	0.12	[2.28, 2.77]				
Perceived Longing	1 Sadness	**2.86**	0.15	[2.58, 3.15]	7.68	**.001**	.06	1 > 2**
	2 Tenderness	**2.11**	0.13	[1.85, 2.37]				
	3 Technical	**2.56**	0.14	[2.28, 2.84]				
Perceived Joy	1 Sadness	**0.52**	0.12	[0.28, 0.76]	27.27	**.000**	.19	2 > 1**
	2 Tenderness	**1.64**	0.11	[1.43, 1.86]				
	3 Technical	**0.74**	0.12	[0.51, 0.98]				
Induced Valence	1 Sadness	**1.90**	0.16	[1.58, 2.22]	4.45	**.013**	.04	2 > 3*
	2 Tenderness	**2.41**	0.15	[2.12, 2.7]				
	3 Technical	**1.82**	0.16	[1.51, 2.13]				
Induced Tense Arousal	1 Sadness	**2.12**	0.17	[1.79, 2.46]	2.05	.132	.02	(none)
	2 Tenderness	**2.46**	0.15	[2.16, 2.76]				
	3 Technical	**2.03**	0.17	[1.70, 2.35]				
Induced Energetic Arousal	1 Sadness	**-0.07**	0.2	[-0.46, 0.31]	1.66	.191	.01	(none)
	2 Tenderness	**0.04**	0.18	[-0.31, 0.38]				
	3 Technical	**-0.42**	0.19	[-0.80, -0.05]				

Adjustment for multiple comparisons: Bonferroni
* = p < .05, ** = p < .001

Table 8.7 *Marginal Estimated Means and ANOVA of most frequently Induced Subjective Feelings and Action Tendencies as a function of Description Condition in Sadness/Tenderness piece*

	Type of Description	Mean	**Std. Error**	**95% CI**	**F (2, 229)**	**p**	**η^2**	**Sig.**
Wanting to make the experience longer	1 Sadness	**2.53**	0.17	[2.20, 2.86]	5.05	.007	0.04	1 > 3*
	2 Tenderness	**2.3**	0.15	[2.01, 2.60]				
	3 Technical	**1.81**	0.16	[1.49, 2.13]				
Wanting to understand more	1 Sadness	**2.21**	0.15	[1.92, 2.50]	6.88	.001	0.06	1 > 3*
	2 Tenderness	**1.81**	0.13	[1.55, 2.07]				
	3 Technical	**1.45**	0.14	[1.17, 1.73]				
Feeling like things do not involve me	1 Sadness	**0.6**	0.12	[0.37, 0.84]	0.35	.705	0.00	(none)
	2 Tenderness	**0.6**	0.11	[0.39, 0.81]				
	3 Technical	**0.48**	0.11	[0.26, 0.71]				
Feeling like crying	1 Sadness	**0.76**	0.12	[0.52, 1.00]	0.72	.488	0.01	(none)
	2 Tenderness	**0.69**	0.11	[0.47, 0.91]				
	3 Technical	**0.88**	0.12	[0.65, 1.12]				
Needing to be comforted	1 Sadness	**1.28**	0.14	[1.00, 1.55]	4.85	.009	0.04	1 > 2* 3 > 2*
	2 Tenderness	**0.74**	0.13	[0.49, 0.99]				
	3 Technical	**1.19**	0.14	[0.92, 1.46]				
Feeling in command of the situation	1 Sadness	**1.2**	0.16	[0.90, 1.51]	9.51	.000	0.08	2 > 1* 2 > 3**
	2 Tenderness	**1.94**	0.14	[1.66, 2.22]				
	3 Technical	**1.14**	0.15	[0.84, 1.44]				
Not being able to concentrate	1 Sadness	**0.66**	0.11	[0.44, 0.89]	2.72	.068	0.02	(none)
	2 Tenderness	**0.31**	0.1	[0.11, 0.51]				
	3 Technical	**0.53**	0.11	[0.31, 0.74]				
Feeling like everything is fine	1 Sadness	**1.51**	0.14	[1.23, 1.80]	20.25	<. 000	0.15	2 > 1** 2 > 3* 3 > 1*
	2 Tenderness	**2.73**	0.13	[2.48, 2.99]				
	3 Technical	**2.00**	0.14	[1.73, 2.28]				

Adjustment for multiple comparisons: Bonferroni. * = p < .05, ** = p < .001

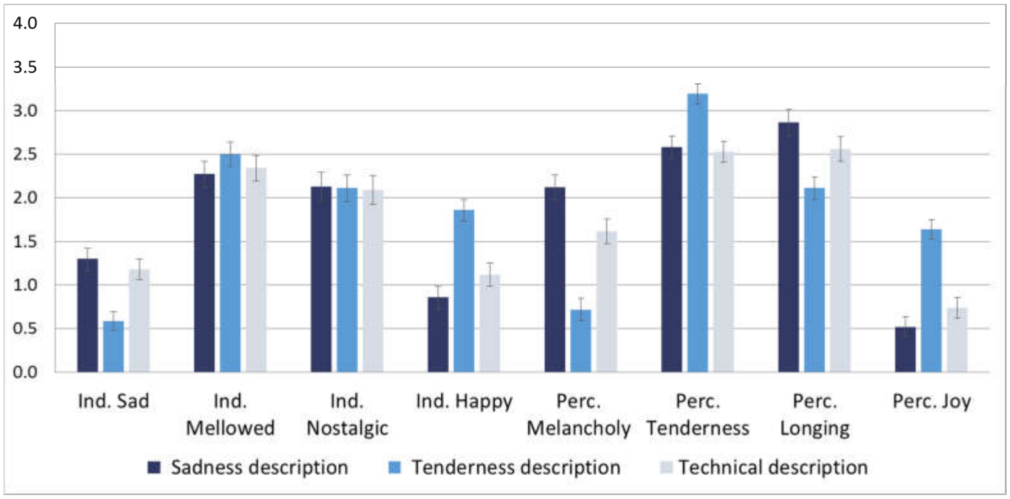


Figure 8.5 E Mean ratings of the most frequently induced and perceived discrete emotions in Sadness/Tenderness piece, as a function of description condition.

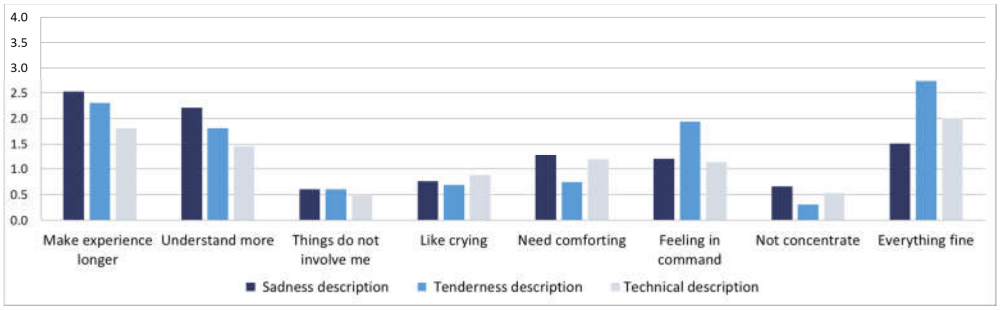


Figure 8.6 Mean ratings of subjective feelings in Sadness/Tenderness piece, as a function of listening condition.

8.5.6.2 Fear / Pride piece: induction and perception of fear, pride, and irritation

Hypothesis 2D predicted that the highest levels of Induced Anxiety and Perceived Fear would be observed in the participants who read the Fear description; and the highest ratings of feeling Triumphant and of Perceived Pride in participants who read the Pride description. All of these trends were found in the data, but the differences between the groups are only statistically significant in the case of Perceived Fear F(2, 234) = 9.88 p < .000, where the Fear description group had significantly higher scores than the Pride description group.

It was also predicted that participants' subjective feelings and action tendencies would be influenced by type of description they read. The results support this hypothesis: participants who read the Fear description reported higher ratings of Needing-to-be-comforted F(2, 229) = 6.29 than the participants who read the Pride description (p = .004), and than the participants who read the Technical description (p = .021). They also had higher scores of Feeling-Frozen F(2, 229) = 4.23 than participants who read the Technical description p = .012; and higher ratings of Feeling-like-crying F(2, 229) = 7.17 than participants who read the Pride description (p = .011), and than participants who read the Technical description (p = .02). This trend is also observed in scores of Wanting-to-avoid-the-situation, and Wanting-to-hide-away, and in scores of Wanting-to-attack-something, where the participants who read the Pride description had higher scores. (All p's > 0.05).

Furthermore, consistent with the prediction, the participants who read the Fear description reported significantly higher ratings of Induced Sadness than participants who read the Pride description F(2, 229) = 9.88 p = .001; and higher rating of Perceived Melancholy than participants who read the Technical description F(2, 229) = 3.96 p = .031. This trend is also observed in the case of Induced Valence, where the Fear description had the lowest scores of all, (p > 0.05).

Finally, although the participants who read the Pride description reported higher ratings of Energetic Arousal than participants who read the Fear description, they did not have the highest ratings of Induced Irritation, nor of Perceived Anger, which were actually reported by the participants who read the Fear description. These trends, again, are non-significant (all p-values >.005). (Table 8.8 presents a summary of the Descriptive data and the ANOVA tests for the results herein presented).

Table 8.8 *Estimated marginal means, standard errors and ANOVA tests of ratings of discrete emotions as a function of Description Condition in the Fear / Pride piece*

	Type of Description	Mean	**Std. Error**	**95% CI**	**F (2, 229)**	**p**	**η^2**	**Sig.**
Induced Triumphant	1 Pride	**1.07**	0.14	[0.79, 1.35]	1.51	.224	0.01	(none)
	2 Fear	**0.75**	0.13	[0.50, 1.01]				
	3 Technical	**0.81**	0.14	[0.53, 1.08]				
Induced Anxious	1 Pride	**2.17**	0.16	[1.85, 2.49]	1.49	.227	0.01	(none)
	2 Fear	**2.2**	0.15	[1.91, 2.50]				
	3 Technical	**1.86**	0.16	[1.54, 2.17]				
Induced Irritated	1 Pride	**0.88**	0.14	[0.60, 1.16]	1.78	.172	0.02	(none)
	2 Fear	**1.21**	0.13	[0.95, 1.46]				
	3 Technical	**0.92**	0.14	[0.64, 1.19]				
Induced Sad	1 Pride	**0.66**	0.12	[0.43, 0.90]	9.88	.000	0.08	2 > 1**
	2 Fear	**1.24**	0.11	[1.03, 1.45]				
	3 Technical	**0.61**	0.12	[0.38, 0.83]				
Perceived Pride	1 Pride	**1.95**	0.17	[1.61, 2.29]	0.92	.399	0.01	(none)
	2 Fear	**1.64**	0.15	[1.33, 1.94]				
	3 Technical	**1.77**	0.17	[1.44, 2.10]				
Perceived Fear	1 Pride	**2.41**	0.15	[2.12, 2.69]	8.86	.000	0.07	2 > 1**
	2 Fear	**3.23**	0.13	[2.97, 3.49]				
	3 Technical	**2.8**	0.14	[2.52, 3.08]				
Perceived Anger	1 Pride	**1.88**	0.16	[1.57, 2.19]	2.77	.065	0.02	(none)
	2 Fear	**2.17**	0.14	[1.89, 2.45]				
	3 Technical	**1.69**	0.15	[1.39, 1.99]				
Perceived Melancholy	1 Pride	**1.13**	0.15	[0.84, 1.43]	3.96	.020	0.03	2 > 3*
	2 Fear	**1.58**	0.14	[1.31, 1.85]				
	3 Technical	**1.06**	0.15	[0.77, 1.35]				
Induced Valence	1 Pride	**-0.71**	0.23	[-1.15, -0.26]	1.19	.308	0.01	(none)
	2 Fear	**-1.04**	0.2	[-1.44, -0.63]				
	3 Technical	**-0.6**	0.22	[-1.03, -0.16]				
Induced Tense Arousal	1 Pride	**-2.01**	0.19	[-2.39, -1.62]	0.39	.675	0.00	(none)
	2 Fear	**-1.77**	0.18	[-2.12, -1.43]				
	3 Technical	**-1.87**	0.19	[-2.25, -1.50]				
Induced Energetic Arousal	1 Pride	**1.23**	0.17	[0.88, 1.57]	2.95	.054	0.03	(none)
	2 Fear	**1.03**	0.16	[0.72, 1.34]				
	3 Technical	**1.59**	0.17	[1.25, 1.92]				

Adjustment for multiple comparisons: Bonferroni * = p < .05, ** = p < .001

Table 8.9 *Estimated marginal means, standard errors and ANOVA tests of ratings of subjective feelings as a function of description condition in the Fear / Pride piece*

	Type of Description	Mean	**Std. Error**	**95% CI**	**F (2, 229)**	**p**	η^2	**Sig.**
Wanting to make the experience longer	1 Pride	**1.10**	0.16	[0.78, 1.42]	0.66	.517	0.01	
	2 Fear	**1.33**	0.14	[1.04, 1.61]				
	3 Technical	**1.13**	0.16	[0.83, 1.44]				
Wanting to avoid the situation	1 Pride	**1.49**	0.18	[1.15, 1.84]	0.22	.802	0.00	
	2 Fear	**1.56**	0.16	[1.25, 1.87]				
	3 Technical	**1.40**	0.17	[1.07, 1.74]				
Wanting to understand more	1 Pride	**1.37**	0.16	[1.06, 1.68]	1.87	.156	0.02	
	2 Fear	**1.78**	0.14	[1.50, 2.06]				
	3 Technical	**1.54**	0.15	[1.24, 1.84]				
Needing to be comforted	1 Pride	**0.39**	0.13	[0.14, 0.64]	6.29	.002	0.05	2>1* 2>3*
	2 Fear	**0.96**	0.12	[0.73, 1.18]				
	3 Technical	**0.49**	0.12	[0.25, 0.74]				
Wanting to attack something	1 Pride	**0.98**	0.14	[0.71, 1.26]	0.9	.410	0.01	
	2 Fear	**0.74**	0.13	[0.49, 0.98]				
	3 Technical	**0.82**	0.13	[0.55, 1.08]				
Feeling like boiling inside	1 Pride	**0.90**	0.13	[0.64, 1.16]	0.74	.477	0.01	
	2 Fear	**0.96**	0.12	[0.73, 1.19]				
	3 Technical	**0.75**	0.13	[0.5, 1.00]				
Feeling in command of the situation	1 Pride	**0.81**	0.13	[0.55, 1.07]	0.06	.938	0.00	
	2 Fear	**0.76**	0.12	[0.53, 1.00]				
	3 Technical	**0.74**	0.13	[0.49, 0.99]				
Wanting to hide away	1 Pride	**2.00**	0.17	[1.68, 2.33]	0.34	.712	0.00	
	2 Fear	**2.06**	0.15	[1.77, 2.36]				
	3 Technical	**1.89**	0.16	[1.57, 2.20]				
Feeling frozen	1 Pride	**1.15**	0.14	[0.87, 1.43]	4.23	.016	0.04	2>3*
	2 Fear	**1.42**	0.13	[1.17, 1.67]				
	3 Technical	**0.88**	0.14	[0.61, 1.15]				
Not being able to concentrate	1 Pride	**0.72**	0.15	[0.43, 1.01]	2.8	.063	0.02	
	2 Fear	**1.15**	0.13	[0.89, 1.42]				
	3 Technical	**1.12**	0.14	[0.84, 1.40]				
Feeling like crying	1 Pride	**0.28**	0.10	[0.08, 0.47]	7.17	.001	.06	2>1* 2>3*
	2 Fear	**0.67**	0.09	[0.49, 0.84]				
	3 Technical	**0.21**	0.10	[0.02, 0.40]				

Adjustment for multiple comparisons: Bonferroni
* = p < .05, ** = p < .001

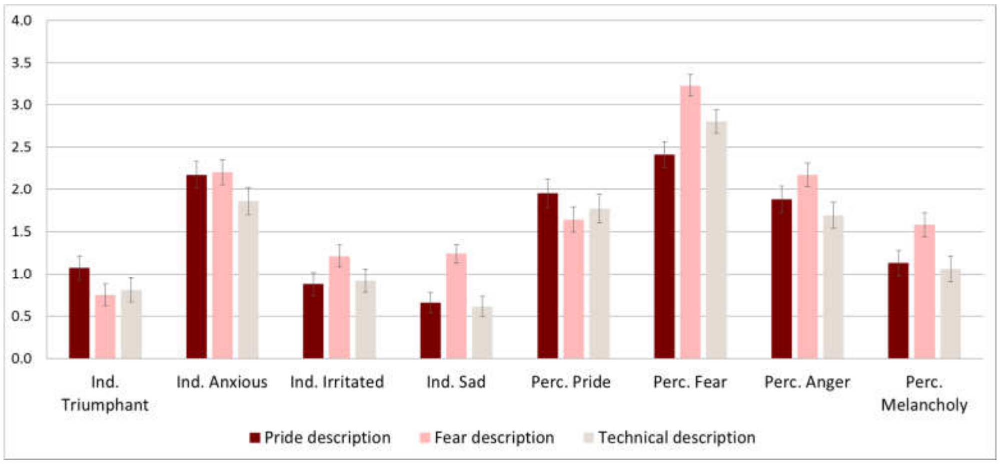


Figure 8.7 Mean ratings of the most frequently induced and perceived discrete emotions in Fear/Pride piece, as a function of description condition.

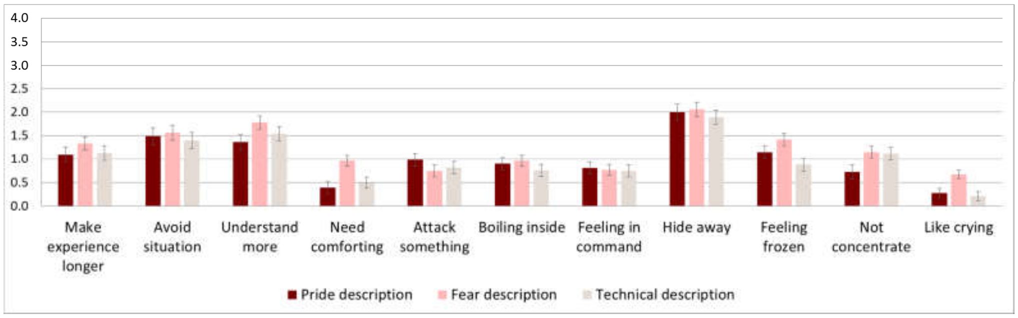


Figure 8.8 Mean ratings of subjective feelings in Fear/Pride piece, as a function of listening condition.

8.5.6.3 Joy / Determination piece: induction and perception of joy and pride

The results of the Factorial ANOVA suggest that, contrary to expectations, the participants who read the Determination description perceived it as more inspiring of positive and happy feelings than the participants who read the Joy description. Consequently, the trend predicted by **Hypothesis 2D** is only partially observed: the participants who read the Determination description experienced the strongest induced feelings of being Triumphant, strong, and higher ratings of Perceived Pride than the participants who read the Joy description, but they also reported the highest ratings of Induced Happiness and of Induced Valence. Nevertheless, only the ratings of Valence were significantly different: the Determination description group had higher scores than the Technical description group F(2, 229) = 4.19 p = .025.

An analysis of the answers to the questionnaire of subjective feelings and action tendencies reveals that as expected, compared to participants who read the Joy description, participants who read the Determination description had slightly higher scores than the other groups of Feeling-in-command-of-the-situation (marginally higher than the Technical description group F(2,234) = 3.14 p = .051). But, unexpectedly, the Determination description group also had the highest ratings of Wanting-to-make-the-experience-longer (significantly higher than the Technical description group F(2,234) = 3.80 p = .022); and of Feeling-like-everything-is-fine (significantly higher than the Technical description group F(2,234) = 4.10 p = .019). These results confirm the conclusion that the participants who read the Determination description had the most positive affective experience while listening to this piece. (See tables 8.10 and 8.11 for a summary of the descriptive data and the ANOVA tests).

Table 8.10 *Estimated marginal means, standard errors and ANOVA tests of ratings of discrete emotions as a function of Description Condition in the Joy / Determination piece*

	Type of Description	Mean	Std. Error	95% CI	F (2, 229)	p	η²	Sig.
Induced Happy	1 Joy	**2.68**	0.14	[2.40, 2.95]	3.17	.044	.03	(None)
	2 Determination	**2.74**	0.13	[2.49, 2.98]				
	3 Technical	**2.30**	0.13	[2.03, 2.57]				
Induced Triumphant	1 Joy	**1.53**	0.16	[1.21, 1.85]	2.21	.112	.02	(None)
	2 Determination	**1.97**	0.15	[1.68, 2.25]				
	3 Technical	**1.90**	0.16	[1.59, 2.21]				
Induced Mellowed	1 Joy	**1.15**	0.14	[0.88, 1.43]	1.11	.332	.01	(None)
	2 Determination	**0.97**	0.13	[0.72, 1.21]				
	3 Technical	**0.86**	0.14	[0.60, 1.13]				
Induced Admiring	1 Joy	**1.46**	0.15	[1.16, 1.76]	1.16	.317	.01	(None)
	2 Determination	**1.45**	0.14	[1.18, 1.72]				
	3 Technical	**1.18**	0.15	[0.89, 1.47]				
Induced Transcen-dent	1 Joy	**1.10**	0.14	[0.82, 1.38]	0.63	.536	.01	(None)
	2 Determination	**1.09**	0.13	[0.84, 1.34]				
	3 Technical	**0.91**	0.14	[0.64, 1.18]				
Perceived Joy	1 Joy	**2.88**	0.15	[2.59, 3.17]	3.07	.048	.03	(None)
	2 Determination	**2.79**	0.13	[2.53, 3.05]				
	3 Technical	**2.41**	0.14	[2.13, 2.69]				
Perceived Pride	1 Joy	**1.22**	0.16	[0.91, 1.53]	2.90	.057	.02	(None)
	2 Determination	**1.53**	0.14	[1.25, 1.81]				
	3 Technical	**1.75**	0.15	[1.45, 2.05]				
Perceived Tenderness	1 Joy	**1.08**	0.12	[0.84, 1.32]	0.33	.716	.00	(None)
	2 Determination	**0.97**	0.11	[0.75, 1.18]				
	3 Technical	**0.95**	0.12	[0.72, 1.19]				
Perceived Spirituality	1 Joy	**1.06**	0.14	[0.80, 1.33]	0.81	.446	.01	(None)
	2 Determination	**0.97**	0.12	[0.73, 1.21]				
	3 Technical	**0.83**	0.13	[0.57, 1.09]				
Induced Valence	1 Joy	**2.76**	0.15	[2.48, 3.05]	4.19	.016	.04	2 >3*
	2 Determination	**2.80**	0.13	[2.54, 3.06]				
	3 Technical	**2.29**	0.14	[2.01, 2.57]				
Induced Tense Arousal	1 Joy	**1.79**	0.19	[1.42, 2.16]	1.56	.213	.01	(None)
	2 Determination	**1.67**	0.17	[1.34, 2.01]				
	3 Technical	**1.35**	0.18	[0.99, 1.71]				
Induced Energetic Arousal	1 Joy	**2.05**	0.19	[1.68, 2.42]	2.10	.125	.02	(None)
	2 Determination	**2.21**	0.17	[1.88, 2.55]				
	3 Technical	**1.71**	0.18	[1.34, 2.07]				

Table 8.11 *Estimated marginal means, standard errors and ANOVA tests of ratings of subjective feelings as a function of description condition in the Joy / Determination piece*

	Type of Description	Mean	**Std. Error**	**95% CI**	**F (2, 229)**	**p**	**η²**	**Sig. Compa-risons**
Wanting to make the experience	1 Joy	**2.23**	0.16	[1.91, 2.55]	3.80	.024	.032	2 > 3 *
	2 Determination	**2.39**	0.15	[2.10, 2.68]				
	3 Technical	**1.81**	0.16	[1.5, 2.120]				
Wanting to understand more	1 Joy	**1.74**	0.16	[1.42, 2.06]	1.37	.257	.012	(None)
	2 Determination	**2.06**	0.15	[1.77, 2.35]				
	3 Technical	**1.77**	0.16	[1.46, 2.08]				
Feeling in command of the situation	1 Joy	**1.88**	0.16	[1.56, 2.20]	3.14	.045	.027	(None)
	2 Determination	**2.26**	0.15	[1.97, 2.55]				
	3 Technical	**1.75**	0.16	[1.44, 2.06]				
Not being able to concentrate	1 Joy	**0.49**	0.12	[0.26, 0.73]	2.57	.079	.022	(None)
	2 Determination	**0.41**	0.11	[0.20, 0.62]				
	3 Technical	**0.76**	0.12	[0.53, 0.99]				
Wanting to dance	1 Joy	**2.03**	0.16	[1.71, 2.34]	1.10	.334	.01	(None)
	2 Determination	**2.09**	0.14	[1.81, 2.37]				
	3 Technical	**1.79**	0.15	[1.49, 2.09]				
Feeling like laughing	1 Joy	**1.17**	0.14	[0.90, 1.45]	0.58	.562	.005	(None)
	2 Determination	**1.28**	0.13	[1.04, 1.53]				
	3 Technical	**1.09**	0.14	[0.82, 1.35]				
Feeling like everything is fine	1 Joy	**2.79**	0.13	[2.53, 3.04]	4.10	.018	.035	2>3*
	2 Determination	**2.89**	0.12	[2.66, 3.12]				
	3 Technical	**2.42**	0.13	[2.17, 2.66]				

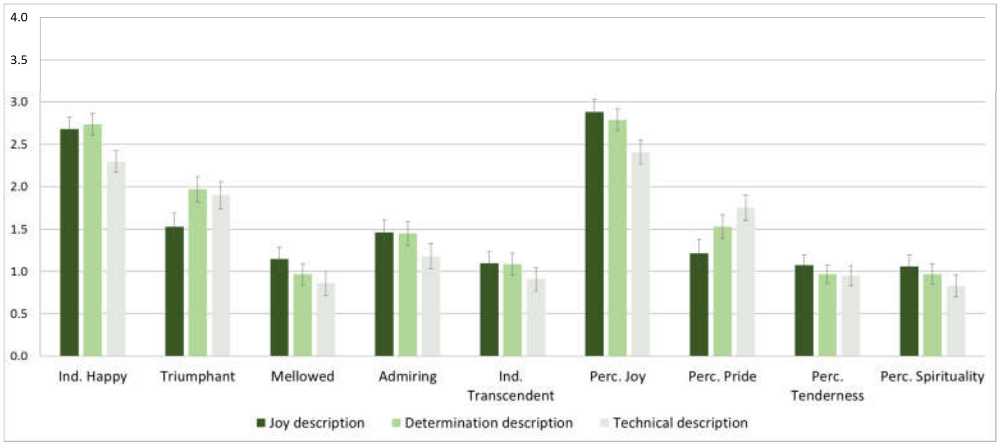


Figure 8.9 Mean ratings of the most frequently induced and perceived discrete emotions in Joy/Determination piece, as a function of description condition.

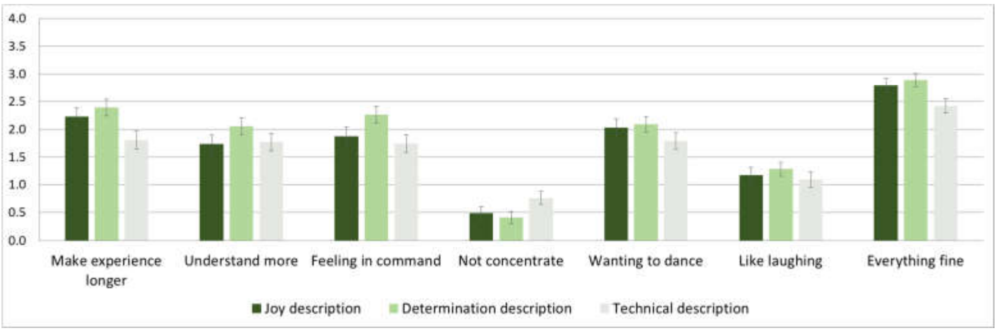


Figure 8.10 Mean ratings of subjective feelings in Joy/Determination piece, as a function of listening condition.

8.5.7 Test of Hypotheses 4 and 5: Did Any Covariates Significantly Mediate the Results?

These hypotheses predicted two mediating effects: Hypothesis 4 predicted that being able to play an instrument present in the piece would correlate positively with reported emotional intensity; and Hypothesis 5 predicted that ratings of feelings of social affiliation evoked by the music would correlate positively with reported emotional intensity.

In this section, I present the results of the tests of these hypotheses, and of the additional tests I carried out to examine whether any other covariates had a significant effect on the dependent measures. I will follow the same rationale and procedure that I used in the previous chapter, where I used MANCOVA tests, followed by confirmatory ANCOVAs, which included only the covariates that the initial MANCOVA test yielded as significant. I also used Bootstrapping (set to 1000 iterations) to calculate the confidence intervals, I applied the Benjamini-Hochberg correction for multiple comparisons, and I applied the Bonferroni correction to the p-values in the post-hoc tests.

The **covariates** included in the tests are:

- *Extent to which the participant is able to play a musical instrument present in the musical piece*. (As in experiment 1, the information provided by the participants about which instruments they can play was rated as an ordinal variable: not being able to play any instrument = 0; being able to play an instrument not present in the piece = 1; being able to play an instrument from the same category of instruments as those present in the piece = 2; being able to play an instrument present in the piece = 3).
- Ratings of *similarity to the typical person who listens to this kind of music*, and ratings of *finding it easy to befriend someone who likes this music*.
- *Musical Engagement,*
- *Enjoyment* of the piece,
- *Familiarity* with the piece.

The **dependent variables** were the same ones as analysed in the previous section: ratings of most intense induced and perceived affective states (including action tendencies), ratings of core affect, and ratings of the induced and perceived discrete emotions with the highest mean scores.

In order to test the assumption of independence of the covariates and the independent variable, I ran ANOVA tests (and Kruskal-Wallis tests where the normality assumption was not met) with Condition as IV, and the scores of each covariate as DV. As can be seen in Table 8.12, several of these covariates violate the assumption: Enjoyment, Level of attention to the task, Musical Engagement, Perceived Difficulty, Social Similarity and Musical Engagement. However, it is also clear from these results that there was not a consistent pattern where one of the experimental groups displayed the same kind of bias in all of these variables. Since the assumption of independence of the covariates and the independent variable is an interpretational, but not a statistical requirement (Field, 2013 p. 486), I proceeded to carry out the MANCOVA tests, keeping in consideration the identified biases in the results.

Table 8.12 *Results of analysis of the assumption of independence of covariates and independent variables*

Variable	Piece	Significant differences
Enjoyment	Sadness / Tenderness	Sadness Description > Technical Description (p = .029)
	Joy / Determination	Simulation > Non-Simulation (p= .014)
Level of Attention to the task	Joy / Determination	Sadness Description > Technical Description (p = .037)
		Tenderness Description > Technical Description (p = 0.20)
Musical Engagement	Joy / Determination	Sadness Description > Technical Description (p= .019)
Difficulty	Sadness / Tenderness	Non-Simulation > Simulation (p = .032)
Social Similarity	Sadness / Tenderness	Sadness Description > Technical Description (p = .022)
Musical Engagement	Sadness / Tenderness	Sadness Description > Technical Description (p = .025)

8.5.7.1 Hypothesis 4: Effect of being able to play an instrument present in the piece

Hypothesis 4 predicted that the more a participant could play an instrument present in the piece, the more intense his or her affective experience would be. This prediction was not supported by the data in any of the dependent variables. (See table 8.13 for a summary of the regression models).

8.5.7.2 Hypothesis 5: Effect of evoked feelings of social affiliation

Hypothesis 5 predicted that the more the pieces evoked feelings of social affiliation in the participants, the more intense their emotional reactions would be. Social affiliation was measured using two questions: one asking the participants to rate how similar they thought they were to the typical person who enjoys that kind of music (I named this variable "Social Similarity"); and a question asking them to rate how easy they would find it to befriend someone who likes that kind of music (I named this variable "Befriending easiness").

The first MANCOVA analyses revealed that none of these covariates were significant mediators. However, once I remove the ratings of Enjoyment from the model, these two variables do show significant effects on several of the dependent measures. Indeed, I found high positive correlations between ratings of enjoyment and these two social affiliation variables (ranging from .32 and .62 in the three pieces, median = .37).

The MANCOVA analyses excluding ratings of enjoyment indicate that, contrary to the prediction in Hypothesis 5, the ratings of Social Similarity and Befriending Easiness were not significant covariates for the variables measuring intensity of the participants' affective experience (Most Intense Induced and Perceived Affect and Emotions). However, these analyses also indicate that these social affiliation variables were significant covariates in several variables related to positive affective states (See table 8.13 for a summary of the regression models):

- In the **Sadness/Tenderness** piece, the ratings of Social Similarity were positive and significant predictors of ratings of Wanting-to-make-the-experience-longer and of Wanting-to-understand-more; and the ratings of Befriending Easiness were positive and significant predictors of ratings of Perceived Tenderness, Feeling-in-command-of-the-situation and of Feeling-like-everything-is-fine.

- In the **Fear/Pride piece**, the ratings of Social Similarity were positive and significant predictors of ratings of Induced Triumphant, Perceived Pride, Valence, Tense Arousal, Wanting-to-make-the-experience-longer, Wanting-to-understand-more; and negative significant predictors of Tense Arousal, Wanting-to-avoid-the-situation and of Needing-to-be-comforted. The ratings of Befriending Easiness, by contrast, were not significant predictors.
- In the **Joy/Determination piece**, the ratings of Social Similarity were positive and significant predictors of ratings of Induced Triumphant, Induced Admiring, Valence, Energetic Arousal, Wanting-to-make-the-experience-longer and of Wanting-to-dance. The scores of Befriend Easiness were not significant predictors for any of the dependent variables.

Importantly, controlling for these two variables does not affect the main results reported in the previous section. In other words, introducing these covariates does not render the differences between the Simulation Conditions significant; and the differences between the groups according to the Description Condition remain the same. In the next section I present the results of the MANCOVA analyses which indicated which other variables were significant covariates of the dependent measures.

8.5.8 Effect of Other Covariates in the Participants' Affective Experience

8.5.8.1 Sadness / Tenderness piece:

As mentioned above, ratings of **Enjoyment** were significant predictors of 16 out of the 24 analysed dependent measures. These scores were positive predictors of ratings of: Most Intense Discrete Emotion, Most Intense Perceived Affect, Most Intense Perceived Discrete Emotion, Induced Mellowed, Induced Nostalgic, Induced Happy, Perceived Tenderness, Perceived Longing, Valence, Tense Arousal, Energetic Arousal, Wanting-to-make-the-experience-longer, Wanting-to-understand-more, Feeling-in-command-of-the-situation, and Feeling-like-everything-is-fine. The scores of Enjoyment were negative predictors only of ratings of Feeling-like-things-do-not-involve-me.

The MANCOVA analyses also reveal that ratings of how much Attention to the task the participants had were positively related to scores of: Wanting-to-make-the-experience-longer, Wanting-to-understand-more, Feeling-like-crying, Needing-to-be-comforted; and a negatively correlated with scores of Feeling-like-things-do-not-involve-me. In the case of the ratings of Needing-to-be-comforted, perceived difficulty was a positive predictor.

The ratings of the extent to which the participants were able to pay attention to the experimental task without distractions, along with ratings of Social Similarity, were positive predictors of scores of Wanting-to-make-the-experience-longer, and of Wanting-to-understand-more.

Importantly, controlling for these covariates does not produce any substantial change in the main results: no effect of Simulation Condition is observed, and the effects of the Description condition remain the same.

8.5.8.2 Fear / Pride piece:

The MANCOVA analyses reveal that ratings of enjoyment were significant, positive predictors of ratings of: Induced Triumphant, Induced Irritated, Perceived Pride, Valence, Energetic Arousal, Wanting-to-make-the-experience-longer, Wanting-to-understand-more; and negative predictors of Wanting-to-avoid-the-situation. Controlling for this covariate does not make the differences between the two simulation conditions significant (Hypothesis 1S), but it makes the ratings of Induced Triumphant significantly higher in the group who read the Pride description than in the group who read the Fear description F(2,228) = 3.36 p = .038.

The ratings of Musical Engagement were, in turn, positive predictors of Perceived Anger. Controlling for this covariate does not produce a substantial change in the main effect of Simulation condition, nor in the main effect of Description condition.

8.5.8.3 Joy / Determination piece:

The ratings of Enjoyment are significant covariates in 20 out of the 24 analysed dependent variables. They are positive predictors of: Most Intense Action Tendency, Most Intense Discrete Emotion, Most Intense Perceived Affect, Most Intense Perceived Discrete Emotion, Induced Happy, Induced Triumphant, Induced Mellowed, Induced Admiring, Induced Transcendent, Perceived Joy, Perceived Pride, Perceived Tenderness, Valence, Tense Arousal, Energetic Arousal, Wanting-to-make-the-experience-longer, Wanting-to-understand-more, Feeling-in- command-of-the-situation, Wanting-to-dance, Feeling-like-laughing, and of Feeling-like-everything-is-fine.

Controlling for the Enjoyment covariate has no effect on the main effect of Simulation; but it makes the scores of Induced Triumphant and Perceived Pride higher in the Joy description group than in the Technical description group F(2,228) = 3.58 p= .049 and F(2,228) = 3.79 p = .019, respectively. (These results do not coincide with the prediction made in Hypothesis 2D).

Ratings of Familiarity were positive, significant predictors of Perceived Tenderness, while ratings of Attention to the experimental task were positive predictors of Energetic Arousal scores, and negative predictors of Not-being-able-to-concentrate-in-my-own-thoughts.

Importantly, ratings of Finding-it-hard-to-stay-still while listening to the music were all negative predictors of 10 dependent variables, almost all of them related to positive affective states: Most Intense Perceived Affect, Most Intense Perceived Discrete Emotion, Induced Happy, Induced Triumphant, Perceived Joy, Energetic Arousal, Wanting-to-make-the-experience-longer, and of Wanting-to-dance.

Finally, controlling for Familiarity, Attention, and being able to remain still do not produce any substantial changes on the main effects of Simulation condition, and on the main effect of Description condition.

Table 8.13 *Summary of significant covariates yielded by the MANCOVA tests (excluding ratings of enjoyment)*

	Dependent variable	**R squared**	**Significant Covariates**	**B coeff.**
Sadness / Tenderness piece	Wanting-to-make-the-experience-longer	0.26**	Social Similarity	0.45*
			Attention to the task	0.24*
	Wanting-to-understand-more	0.19*	Social Similarity	0.28*
			Attention to the task	0.19*
	Perceived Tenderness	0.16**	Befriending Easiness	0.22*
	Feeling-in-command-of-the-situation	0.13**		0.25*
	Feeling-like-everything-is-fine	0.23**		0.25*
	Needing-to-be-comforted	0.12**	Difficulty	0.23*
			Attention to the task	0.22*
	Feeling-like-things-do-not-involve-me	0.08*	Attention to the task	-0.22**
	Feeling-like-crying	0.09*		0.22*
Fear / Pride piece	Ind. Triumphant	0.10*	Social Similarity	0.26**
	Perceived Pride	0.09*		0.29**
	Valence	0.10*		0.43**
	Wanting-to-make-the-experience-longer	0.25**		0.52**
	Wanting-to-avoid-the-situation	0.11**		-0.37**
	Wanting-to-understand-more	0.19**		0.42**
	Perceived Anger	0.11**	Musical Engagement	0.09**
Joy / Determination piece	Ind. Admiring	0.06*	Social Similarity	0.24*
	Valence	0.10**		0.24*
	Energy Arousal	0.07*		0.27*
	Wanting-to-make-the-experience-longer	0.13**		0.33**
	Wanting-to-dance	0.09*		0.21*
	Most Intense Perceived Affect	0.07*	Being able not to move	-0.15*
	Most Intense Perceived Discrete Emotion	0.08*		-0.015*
	Ind. Happy	0.11**		-0.024*
	Ind. Triumphant	0.08*		-0.025*
	Perceived Joy	0.10*		-0.022*
	Energy Arousal	0.07*		-0.026*
	Wanting-to-make-the-experience-longer	0.10**		-0.021*
	Wanting-to-dance	0.12**		-0.026*
	Energy Arousal	0.6*	Attention to the task	0.024*
	Not-being-able-to-concentrate	0.1**		-0.017*
	Perceived Tenderness	0.08*	Familiarity	0.54*

8.5.9 Visual Imagery and Semantic Associations Evoked by the Music and the Descriptions

In this section, I analyse the qualitative data obtained from the answers to the open-ended question: "*what went through your mind while you were listening to the music*", that the participants filled after listening to each piece. The objective of these analyses is to better understand how manipulating the description of the piece affected the participants' emotional experience, as predicted in **hypothesis 2D.**

First of all, it is important to note that some participants chose not to answer this question: 10% in the Sadness/Tenderness piece, 15 % in the Fear/Pride piece, and 15% in the Joy/Determination piece). Also, five participants (equivalent to 2.5% of the sample) rejected the description provided before the piece, commenting that it did not seem to fit with the music. Two examples:

> *"Didn't believe that the description of the composer and the compositional situation was true. Didn't match the music."*

Participant in the Non-Simulation, Tenderness description condition, whose
highest scores in the in the Sadness /Tenderness piece were Perceived
Peacefulness = 2, Perceived Longing = 2; Induced Nostalgia = 3.

> *"I was trying to correlate the description of the piece with what I was listening to, but to my ears the piece does not bring along pride and triumph, rather horror and agony."*

Participant in the Non-Simulation, Pride description condition,
whose highest scores in the in the Fear/Pride piece were
perceived Anger = 4; Induced Irritated = 4.

Nevertheless, it can be safely assumed that these cases of extreme discomfort with the provided description were a minority. Moreover, an analysis of the answers from the participants in the Technical description condition (who read neutral descriptions of the pieces), reveals that their imagery contained similar themes to the descriptions read by other two groups. This suggests that the provided emotional descriptions actually matched the type of semantic associations that a listener might spontaneously evoke while listening to these pieces. Some examples:

"A sad scene. The end. If it was in a movie, a main character could have just died and the music will go with scenes of people mourning."

Participant in the Simulation, Technical description condition, whose highest scores in the Sadness /Tenderness piece were perceived Melancholy = 4, Perceived Spirituality = 3; Induced Sad = 3.

"Preparación para batalla, un mal presagio, suspenso, derrota" (Translation: *"Preparation for a battle, a bad omen, suspense, defeat"*)

Participant in the Simulation, Technical description condition, whose highest scores in the Fear/Pride piece were perceived Anger = 3, Perceived Fear = 3; Induced Anxious = 3.

"I thought it was very strong, powerful, determined. Like someone was about to embark on a mission, or to start a task, but not a scary one. I liked it, it was exciting, but it isn't the sort of music I usually listen to in my own time. I could imagine it being used in a film"

Participant in the Simulation, Technical description condition, whose highest scores in the Joy / Determination piece were perceived Pride = 4, Perceived Joy = 2; Induced Triumphant = 3, Induced Admiring = 3.

I used the same procedure as in experiment 1 to analyse the extent to which the participants' narratives coincided with the emotion they reported in the questionnaires. I coded the qualitative data into three categorical variables. The first two variables indicate whether there was a coincidence between the content of the narrative, and the participant's highest scores of perceived, and induced emotions, correspondingly. I assigned a value of 1 if the content of the narrative matched the highest perceived/ induced emotion, and a value of 0, if they did not. The third variable indicates whether there were explicit elements from the provided description in the participants' narratives. Again, I assigned a value of 1 if the content of the narrative contained images or elements from the description, and a value of 0, if it did not. Importantly, this third analysis excludes the participants from the "Technical description" condition, because the descriptions they read did not contain any hint that the music communicated an emotion.

In the **Sadness/ Tenderness** piece, the coincidence rate between the participants' ratings of perceived emotions and their narratives was of 65.88% and of 60.19% for their ratings of induced emotions. These rates are lower than the ones observed in experiment 1 (84.68% and 79.84%, correspondingly). The analysis of the presence of elements from the provided description in the participants' narratives (restricted to Description groups 1 and 2) shows that only a third of the participants (32.62%) explicitly mentioned an element of the description in their narratives. Some examples of the participants' narratives:

"Actually I imagined a child being wrapped up in a quilt, and being cuddle [sic] by his mom."

Participant in the Non-simulation, Tenderness description condition,
whose highest scores in the Sadness /Tenderness piece were
perceived Joy = 4, Tenderness = 3, Peacefulness = 3;
and Induced Mellowed = 4.

"I felt very far away from something I loved very much. I wanted to be soothed and told it would be ok. Both of these however were quite enjoyable feelings."

Participant in the Simulation, Sadness description condition, whose highest
scores in the Sadness /Tenderness piece were perceived Longing = 4, Melancholy = 4,
Tenderness = 3; and Induced Mellowed = 4,
Induced Sad = 4, Induced Nostalgia = 3.

"It started sad, but seemed to become more uplifted. Reminded me of spring and the seasons changing."

Participant in the Non-Simulation, Sadness description condition, whose highest scores
in the Sadness /Tenderness piece were perceived Peacefulness = 3, Longing = 3;
Tenderness = 3; and Induced Mellowed = 4,
Induced Nostalgic = 3, Relaxed = 3.

In the **Fear/Pride** piece, the coincidence rate between the participants' narratives and their scores of perceived emotions was of 71.86%, and of 69.85% for their scores of induced emotions. Again, these rates are lower those of experiment 1 for the same piece (91.13% and 72.58%, correspondingly). The presence of elements from the provided description in the participants' narratives (description groups 1 and 2) was observed in 39.55% of the cases. Some examples:

> *"This piece of music elicited intense emotions in me, of dread and anxiety. I felt tense and I could readily imagine the experiences which inspired this music-bombs dropping, war, fire... I think the composer certainly achieved his aim in that respect."*
>
> Participant in the Simulation, Fear description condition, whose highest scores in the Fear/Pride piece were perceived Fear = 4, Melancholy = 4, Anger = 3; and Induced Anxious = 3.

> *"This track referred to me pictures of ancient or future battles. Like I was ready for them, like I needed to save someone."*
>
> Participant in the Simulation, Pride description condition, whose highest scores in the Fear/Pride piece were perceived Pride = 2; Induced Triumphant = 4, and Transcendent = 4.

> "*It seemed like someone was trying to kill me with the knife"* [sic]
>
> Participant in the Non-Simulation, Pride description condition, whose highest scores in the Fear/Pride piece were perceived Anger = 3, Perceived Fear = 4; Induced Anxious = 4.

In the **Joy / Determination** piece, the coincidence rate between the participants' ratings of perceived emotions and their narratives was of 61.50%, and of 63% for their ratings of induced emotions. (These percentages are lower than the percentages observed in experiment 1, which were of 77.42%, and of 69.35%, respectively). Elements from the provided description in the participants' narratives were present in 40.14% of the cases (description groups 1 and 2). Some examples:

> *"A forest, animals trotting about together but also a bit of impending doom"*
>
> Participant in the Non Simulation, Joy description condition, whose highest scores in the Joy / Determination piece were perceived Tenderness = 3, Perceived Pride = 2, Perceived Joy = 2; Induced Happy = 3, Induced Mellowed = 3, Induced Admiring = 3.

> *"I thought of myself on an adventure. I felt upbeat, excited and ready to explore. I imagined myself in woodlands, marching along with purpose."*
>
> Participant in the Non-Simulation, Determination description condition, whose highest scores in the Joy / Determination piece were perceived Pride = 4, Perceived Joy = 3; Induced Happy = 3, Induced Triumphant = 3.

> *"It seemed like a motivational song, like after listening you wanted to get to work. It was very uplifting."*
>
> Participant in the Simulation, Determination description condition, whose highest scores in the Joy / Determination piece were perceived Pride = 4, Perceived Joy = 3;
> Induced Happy = 4, Induced Triumphant = 4.

Finally, just like in experiment 1, many participants commented that the pieces reminded them of movie soundtracks (but only two participants explicitly guessed the movie were two the pieces belonged to). In most cases, the mental imagery that these associations evoked were not inspired by specific movies, but by associations with movie genres. The exception to this is the third piece where, just as in experiment 1, several participants commented that the music reminded it of the Lord of the Rings, or The Hobbit.

8.6 Discussion of results from experiment 2

The aims of this experiment were to continue exploring the role of embodied simulation in emotional contagion with music, implementing an improved methodological strategy[30]; and to test new hypotheses about the mediating effects of contextual information, and of feelings of social affiliation in this phenomenon.

8.6.1 Effects of Embodied Simulation, Musical Expertise, and Interactions

Hypothesis 1 predicted that engaging in a mental task that activated motor simulation would lead to more emotional intensity than engaging in a mental task that prevented the activation of simulation mechanisms. The results of this experiment did not support this hypothesis. Just as in experiment 1, the predicted trend was observed in several of the dependent variables, but the effect was not large enough to be statistically significant. Similarly, hypothesis 4 predicted that being able to play an instrument present in the piece would facilitate simulation and be associated with stronger emotional experiences. This prediction was not supported by the results either.

In my interpretation of the results of experiment 1, I speculated that only when the mimicry of the implied musicians' gestures has some emotional connotation for the listener, would it facilitate the perception and induction of musical emotions. This interpretation led me to predict an interaction effect; namely, that participants who did the simulation task and read the emotional descriptions would have the most intense emotional experiences, and conversely, that participants who did the non-simulation task and read the neutral descriptions would have the least intense ones (**hypothesis 3**). This hypothesis was not supported by the data. In fact, reading an emotional description (as compared to reading a neutral description) did not have a significant effect on the intensity of the emotions reported by the participants. This finding suggests that other factors, not the presence or absence of emotional elements in the descriptions were more important in producing the participants' emotional reactions. The emotional descriptions, as I explain in detail below, had an effect on the *type* of perceived and induced emotions, not on their *intensity*.

---

[30] I evaluate the effectiveness of the implemented methodology in the Conclusions chapter of the thesis.

Could these null results be attributed to the tasks having failed in generating the intended simulation and non-simulation conditions? I find this explanation unlikely. Previous research has shown that engaging in imagery of motor actions correlates with the activation of the same brain areas involved in performing those actions (Bangert et al., 2006; Jeannerod, 1995; Jeannerod & Frak, 1999; Zatorre & Halpern, 2005), suggesting that the task designed to facilitate simulation was valid. And on the other hand, many of the free-descriptions provided by the participants of the non-simulation condition about what they thought while listening to the music, include comments about having noticed small glitches in the musical pieces, suggesting that they assumed the intended third-person perspective during the listening task. Moreover, these null results cannot be attributed to the participants having failed in performing the mental task adequately, because I only included in the analyses those participants who reported having followed the instructions correctly, without any distractions or interruptions.

8.6.2 Effect of extra-musical information

Hypothesis 2 predicted that providing participants with fictitious descriptions about the composer and his or her motivation to compose the music would bias the type of perceived and induced emotions they would experience. The results support this prediction. Even though reading an emotional description (as opposed to a neutral one) did not have an impact on the intensity of the reported emotions, the type of emotional description had a coherent effect on the quality of the perceived and induced emotions reported by the participants. This effect, however, was not equally marked in the three pieces: it was most clearly observed in the Sadness/Tenderness piece, where both perceived and induced emotions were biased by the descriptions. In the Fear/Pride and the Joy/Determination pieces the predicted trends are observed in the ratings of perceived and induced emotions and in the answers to the Action Tendencies questionnaire, but the differences between the groups are not always statistically significant.

This mixed pattern of results can be in part attributed to the pieces having different levels of ambiguity: it is possible that the Sadness/Tenderness piece was more expressively ambiguous than the other two. In the case of the Fear/Pride piece, it is also conceivable that individual differences in the enjoyment of “scary” aesthetic stimuli and in musical training played an important role. Thus, participants with more musical training and more tendency to enjoy dissonant and loud music probably found it easier to perceive this piece as expressive of pride, power, or triumph, and consequently to undergo the corresponding induced emotions. Whereas for participants who do not usually enjoy this kind of music, the stimulus was so aversive that they could only perceive it as “scary” and the music could only induce feelings of anxiety and fear. The results in the case of the Joy/ Determination piece in turn, may be due to the fact that there was not an adjective in the questionnaire explicitly asking participants to rate how “determined” they felt after listening to the piece. The closer option was to report feeling “triumphant, strong” but perhaps participants found it strange to report feelings of triumph when the description of the piece mentioned that the characters portrayed in the music were about to *start* their journey. Furthermore, these findings are also consistent with the fact that positive emotional states tend to be less differentiated, and that in most languages (including English) there are fewer emotional adjectives to describe nuances in positively valenced and high-arousal emotions than to describe negatively valenced emotions (Rozin, Berman, & Royzman, 2010).

It is also worth noting that, in general terms the observed effect sizes were small, and that the significant differences were not always found between the neutral description group and the emotional description groups, but between the two emotional description groups. One possible explanation for this finding is that perhaps the emotional descriptions did not fit well with the musical materials. This possibility, however, is improbable. The results from the open-ended questions about what the participants thought about while listening to the music indicated that very few participants considered that descriptions did not match the music. Moreover, most participants who read the neutral descriptions evoked narratives and mental images that were compatible with the descriptions provided to the other two groups. Hence, a better interpretation of the results is that due to the artificial listening circumstances of the experiment, the descriptions had little power, but probably in real-life listening circumstances, many contextual and extra-musical clues can add up (e.g. the CD covers and booklets, lyrics, details about the musician’s biography, meaning of the social occasion, etc.), having a larger impact on the way listeners construct emotional meanings and emotional responses to the music.

8.7 General discussion

8.7.1 Does Embodied Simulation Play a Crucial Role in Emotional Contagion with Music?

Taken together, the results of these two experiments suggest that if motor embodied simulation plays a role in emotional experiences with music, this role is quite small, and probably masked by the effect of other mechanisms simultaneously activated during the listening episode. Indeed, the most influential contemporary theories on the induction of musical emotions, namely, the BRECVEMA theory (Juslin, 2013b) and the Multifactorial Process Model (Scherer & Coutinho, 2013) propose that there are multiple mechanisms or routes to emotion induction, but they have not fully specified under which circumstances each mechanism has predominant effects over others in the emotion-eliciting process. Future studies should therefore investigate which factors in the music, the person and the situation make embodied simulation the maximal mechanism for emotion induction. This line of research would help us understand why, for example, some people seem to derive great pleasure from "air-playing" while listening to music. Is this mimicry the cause, the consequence of the emotional reaction, or both? Is this effect only possible when music evokes positive emotional states? Is it due to a sense of enhanced personal agency, to a sense of synchronization with another real or virtual human being (Launay, Dean, & Bailes, 2013), or even to a sense of merged subjectivity with the music (Clarke, 2014)? To what extent does this pleasurable experience relate to the listener's real ability to play the instruments? These are all interesting questions that await an empirical answer.

My claim, however, is not that embodied simulation is not involved in music perception. The close link between perceiving, predicting, and executing motor actions has been demonstrated in several behavioural and neuroimaging studies (Chen *et al.*, 2008; Leman *et al.*, 2009; Stupacher, Hove, Novembre, Schütz-Bosbach, & Keller, 2013); suggesting that perceiving musical sounds probably involves the activation of internal mimicry mechanisms, producing an implicit notion of music as an activity produced by human agency (Launay, 2015). In other words, it is likely that thanks to embodied simulation, we have an implicit understanding that the sounds (at least when coming from traditional musical instruments, not purely electronic ones) are the consequence of motor actions executed by other human bodies on sound-producing materials (including their own vocal tracts).

While it is possible that embodied simulation of motor actions plays a central role in music perception, my interpretation of the results of these two experiments is that this mechanism does not have consequences for the elicitation of emotional experiences with music, and if it does, its effects are very small. I dedicate the next paragraphs to articulate the arguments for this conclusion. These arguments resemble the criticisms independently proposed by several authors who have challenged the assumption that such complex psychological processes as empathy, mentalizing (i.e. "mind reading"), and social cognition in general, depend on internal mimicry of motor actions supported by mirror-neuron systems (Decety, 2010; Jacob, 2008; Jacob & Jeannerod, 2005).

The first argument is that having a first-person notion of the motor actions involved in playing a musical instrument or in producing a melody does not involve perceiving those actions and their associated sounds as embedded with emotional meanings. For example, it is conceivable that embodied simulation helps us understand that in order to make a musical instrument sound loud, the musician has to make a powerful bodily movement, but this implicit understanding of the immediate goal behind the musician's action does not equate to inferring that the loud sound intends to communicate an emotion of anger, joy, despair, fear, hope, etc. According to this account, motor actions, like gestures, only acquire emotional meaning when they are placed in relation to the wider context in which they are observed or produced. While there is empirical evidence about this in the case of perception of faces (Barrett *et al.*, 2011; Carroll & Russell, 1996) simply doing a mental experiment similar to the one proposed by Jacob and Jeanneord (Jacob & Jeannerod, 2005) demonstrates that the same principle can be applied to the case of bodily gestures and musical actions: consider how the same observed action (e.g. frowning, cutting someone's abdomen with a scalpel, playing a trumpet loudly) has very different emotional goals and meanings according to the context in which they occur (frowning can communicate anger to an adversary, or physical exertion when lifting a heavy weight; cutting someone with a scalpel can be done by a psychopath torturing another person, or by a surgeon performing a surgery; playing a loud note in a trumpet loudly can have the intention of communicating joy, but also anger, etc.). Although the embodied mechanism explains how we perceive these actions as produced by human agents who performed particular bodily movements, it cannot by itself, explain what the *emotional* intention of the agents was. Inferring that intention requires accessing and processing more information about the observed person (or about the listened musical sound) and the context where the action (or music) takes place.

In the context of music listening, this argument has to be refined even further. The results from the second experiment suggest that the presence of a relevant emotional context, such as learning about the emotional intentions of the composer, is not enough to reinforce the effect of simulation. The participants who engaged in simulation and read emotional descriptions of the pieces, did not report more intense emotions than the participants who did not engage in simulation and read neutral descriptions. This observation suggests that if simulation is to have a reinforcing effect on the listeners' emotional experience, it is necessary that they map the simulated movements and melodies onto emotional meanings. For instance, it is not enough that the listeners perceive that the piece expresses anger in general, it is necessary that they associate the specific movements that make the instruments sound loud and fast with the experience of producing an aggressive discharge of physical power against a rival.

A second argument for the claim that motor simulation plays a small role in musical emotions, is that theories like that of Overy and Molnar-Szakacs (Molnar-Szakacs & Overy, 2006; Overy & Molnar-Szakacs, 2009), Jackendoff and Lerdahl (Jackendoff & Lerdahl, 2006) and Davies (Davies, 1994, 2013) reduce emotional experiences to behaviours or gestures, mistaking the part for the whole. Gestures and expressive behaviours are merely *one* of the components of emotional experiences, which always include the evaluation of an event as personally relevant for our goals within a given context (Clore & Ortony, 2013; Scherer, 2005). It follows that simulating or mimicking gestures or behaviours can only be at most, one contributing mechanism to the perception and induction of musical emotions amongst others, as proposed by the Multifactorial Process Model (Scherer & Coutinho, 2013) and the BRECVEMA theory (Juslin, 2013b).

This reasoning can also help explain the finding that mimicry has limited effects on emotional elicitation. Both the experiments here reported, and previous studies in which participants mimicked observed emotional expressions, have found that this manipulation facilitates and biases the perception and induction of coherent affective states (i.e. changes in valence and arousal), but it does not lead to the induction of full-blown emotional experiences (Flack, 2006; Hatfield *et al.*, 1995; Hess & Blairy, 2001; Mcintosh, 2006; Neumann & Strack, 2000). This is true even in studies where participants observed and mimicked facial expressions, which are the type of stimuli with the greatest ability to communicate affective states (Russell *et al.*, 2003). Hence it can be expected that more ambiguous stimuli like vocalizations, bodily gestures, and musical sounds, should be even less effective in communicating and inducing discrete emotions via mimicry mechanisms.

So far, my arguments have focused on the motor type of simulation, which consists in an internal mimicry of the actions performed by the musicians, not on vocal simulation, which consists in an internal mimicry of melodies. Admittedly, the results of the second experiment do not rule out that embodied simulation of the *melodic* aspects of the music has a role in the induction of emotional responses to music (as proposed by the BRECVEMA theory, Juslin, 2013b). However, it is worth noting that the results of experiment 1 do contradict this possibility: the participants who engaged in vocal simulation tended to have the least intense emotions of all the groups.

Finally, my assertion that motor simulation makes a small contribution to emotional contagion with music does not preclude the possibility that other types of embodied mappings between music and motion occur while listening to music. It is probable, as Clarke has proposed (2005) that listening to music evokes the perception of objects in movement (including the listener's own body), or that musical sounds involves the projection of the perceived sounds into supra-modal embodied metaphors as proposed by Johnson and Larson (2003). However, even if these theories are correct, they still face the same challenge that in my view, simulation theory has not met so far: specifying in detail how these virtual or metaphoric experiences of motion in music relate to, or acquire emotional meanings, and how they contribute to the induction of emotions. Clarifying how these embodied processes become "emotional" will allow researchers to test hypotheses in future studies.

8.7.2 What Is the Role of Visual Imagery and Extra-Musical Semantic Information in Emotional Contagion with Music?

In both experiments, the analyses of the participants' answers to the question about what they thought while listening to the music indicate that the majority of them evoked visual images, and that the content of that imagery coincided with the type of perceived and induced emotions they experienced. These findings parallel the results of the experiment carried out by Vuoskoski and Eerola (2013), where the participants reported imagining scenes related to the narratives these researchers provided before listening to the music. For Vuoskoski and Eerola, this visual imagery mechanism (Juslin & Västfjäll, 2008) was activated by an interaction of the music and the provided narratives, and led to the induction of emotional responses in the participants. In my view, the results of the present experiments make this explanation plausible, but incomplete.

My interpretation is that while the visual imagery evoked by the participants might have contributed to their emotional experiences, this visual imagery was actually a consequence of a more basic process: the activation of semantic information primed by the musical materials, and by the descriptions. I based this conclusion in the following observations: first, it is possible that the visual imagery that the participants experienced was simply a consequence of the fact that the experiments did not have provided them with any meaningful visual stimulation while listening to the music (Thompson & Coltheart, 2008). Second, past research has shown that mental imagery can be considered an epiphenomenon, and is not directly implicated in tasks involving the use of abstract concepts (Pecher *et al.*, 2009). Third, although there were high levels of agreement in the emotions they reported, in both experiments there was room for individual differences within the narratives and imagery that the participants evoked. Moreover, in the second experiment, the percentage of participants who explicitly mentioned (at least some) elements from the provided descriptions reached less than 41% of the sample. This variation suggests that personal associations were powerful factors that drove the participants' affective experience. However, at the same time, the high levels of agreement in the reported emotions indicate that these idiosyncratic narratives and imagery were first primed by shared cultural knowledge activated by the music (and by the provided descriptions, in the second experiment).

8.7.3 Do the Observed Results Correspond to Emotional Contagion or to Empathy?

The finding in experiment 1 that the ratings of enjoyment were the most important covariate in the results led me to suggest that the participants experienced the music as specifying a social other, and that this in turn might have provoked in them empathic attitudes towards this "virtual other". In the second experiment, based on these considerations, I asked the participants about the social attitudes evoked by the musical pieces, in order to explore the possibility that what has been called emotional contagion with music can be better characterised as musical empathy. I discuss these two alternatives in this section.

8.7.3.1 The contagion alternative:

According to the BRECVEMA theory (Juslin, 2013b), observing a correspondence between perceived and induced emotions is explained by an automatic process of internal mimicry whereby perceiving an emotion expressed by the music leads to the induction of the same discrete emotion. This theory claims that this mechanism leads to the induction of *basic emotions*, because the phylogenetic importance that these emotions have had in our evolution as a species is reflected in the way we perceive emotions in vocalizations and in music (Juslin, 2013c). If this theory is correct, it follows that basic emotions should be more easily perceived and aroused by music than other emotions, and that it should be less possible to change the type of emotion perceived and induced by manipulating the contextual information that the listener has access to.

The results of the present experiments do not support these predictions, for several reasons. First, both experiments showed a “bleeding” effect: most participants did not choose only one category to rate their perceived and induced emotions; they chose several categories which were always compatible in terms of valence and/or arousal. While these results could be attributed to the ambiguous character of the stimuli used in these experiments, it should be noted that this effect has been found in many experiments on mimicry of facial and vocal expressions (Flack, 2006; Hatfield *et al.*, 1995; Hess & Blairy, 2001; Mcintosh, 2006; Neumann & Strack, 2000), and in previous experiments on induction of musical emotions in which the researchers used clearer stimuli (e.g. Juslin *et al.*, 2013; Kallinen & Ravaja, 2006; Lundqvist, Carlsson, Hilmersson, & Juslin, 2009).

A second argument against the claims of the BRECVEMA theory of emotional contagion is that the participants readily chose non-basic emotions to describe both the affective states expressed by the music, and aroused in themselves (e.g. Nostalgia, Pride, Transcendence, Mellowness). This cannot be attributed to the effect of the provided emotional descriptions in experiment 2, because this effect was also observed in the group of participants who read the neutral descriptions, and in experiment 1, where no descriptions were provided. It seems that just as it has been found in research with the perception of faces and voices (Russell *et al.*, 2003), finding that basic emotions are privileged in the participants’ answers depends largely on using only basic emotions in the list of adjectives they have to choose from.

Third, the results of these two studies indicate that rather than mere perception and mimicry, appraisal mechanisms mediated the participants’ responses, producing emotions that did not correspond to the perceived emotion. In both experiments, the most evident example of this was the finding that many participants perceived the Fear/Pride piece to be expressive of “anger”, and reported feeling “anxious”. This type of responses cannot be attributed to mimicry (which would lead to induced “irritation” or feelings of “power, pride”) but to an evaluation of the musical stimulus as “threatening”, which elicited a defensive response of fear or anxiety.

The activation of appraisal mechanisms can also be demonstrated in the mediating role that aesthetic evaluations and estimations of enjoyment had in the results, which in many cases made the difference between not responding emotionally to the music, and responding with a more or less strong emotion. For instance, some participants had the experience of perceiving that a piece of music expressed a particular emotion (e.g. joy, sadness, or pride), but reported feeling mostly “admiration, wonder” in response. Other participants in contrast, reported disliking the music, and in consequence they reported that it did not elicit any induced emotions, or at most, feelings of boredom and/or irritation. Furthermore, enjoyment ratings not only made the difference between having subdued or strong responses, but also influenced the *type* of induced emotions: for example, those participants who enjoyed the Fear/Pride piece reported feeling “strong, powerful, proud”, whereas those who did not, reported feeling either “anxious” or “irritated”.

The authors behind the BRECVEMA theory, just like authors who defend the Basic Emotion theory in general (Ekman, 1992; Izard, 2009; Panksepp, 1992), would probably respond to these criticisms by arguing that this type of variability in participants' responses is to be expected because musical emotions (like emotions in general) interact with other mechanisms and contextual factors producing nuances in what was originally a basic emotion. However, in the face of this argument, one is left wondering: under which precise circumstances is the predicted correspondence between the perception and induction of basic emotions observable? Unless these circumstances and interactions are fully specified, the logical conclusion from this debate is that these authors are using what Popper called an *ad-hoc hypothesis* (1935/1992), that is, a strategy where a researcher evades the falsification of their original hypothesis by proposing unsupported adjustments.

An alternative, more parsimonious and fruitful alternative is to assume that music is only capable of expressing diffuse affective states, and therefore, if emotional contagion with music happens, we should expect to observe correspondence of expressed and induced emotions in terms of variations in core affect (i.e. valence and arousal), but not of discrete emotions. In fact, several authors have used the term “contagion” in this sense in their research (e.g. Egermann & McAdams, 2013; Evans & Schubert, 2008). In my view, in order to advance in the research of this phenomenon, it is necessary that future researchers make their theoretical assumptions more explicit. They need to specify if they are using the term “emotional contagion” in a merely descriptive sense (without any commitment to explaining how the observed correspondence is produced), or if they are using the term in a theoretical sense; and if so, whether they subscribe to a Basic Emotion approach, or to a Dimensional one.

8.7.3.2 The empathy alternative:

What evidence is there in these experiments for the presence of empathic responses in the participants? The answer depends on the definition of empathy one embraces.

If we define empathy in a broad sense, namely, as sharing emotions that we perceive in another social agent (Preston & de Waal, 2002), then there is some evidence for the presence of empathy experiences in the second experiment: the two variables measuring social affiliation were significant covariates for several dependent measures (after removing ratings of enjoyment from the regression model). This finding parallels the results of Egermann & McAdams’ study (2013), who found that ratings of the extent to which the participants “empathised” with the musicians predicted a significant portion of the variance in felt valence and arousal, after removing the effect of preference.

To some extent, the finding that social affiliation attitudes mediated the participants’ responses is not surprising. After all, there is abundant evidence that some of the functions that music fulfils in people’s lives are “social”: music works as a referent for the construction of social identity (DeNora, 2000; MacDonald, Hargreaves, & Miell, 2002; Schäfer & Sedlmeier, 2010), music can enforce social communication (Livingstone & Thompson, 2009) and facilitates social cohesion (Schubert, 2009). From a wide perspective on empathy, then, it can be argued that since the listeners implicitly experienced the music as evocative of social referents, then we can assume that emotional contagion with music involves the activation of empathic mechanisms.

Despite these arguments, I find this conclusion unsatisfactory. In my view, adopting such a broad definition of empathy does not allow us to distinguish instances of contagion from instances of empathy, making the empathy construct less useful. I propose, following the proposals of Coplan (2011) and of de Vignemont and Singer (2006) that we reserve the term “musical empathy” for those cases in which the listener is explicitly aware of the presence of another (real or imagined) social agent, to whom he or she attributes the ownership of the feelings that the music portrays. Hence, in an empathic response, the listener activates both *cognitive* mechanisms, (in order to distinguish oneself from the observed other, and to simulate the observed person’s appraisal of the emotional event); and *affective* mechanisms, in order to feel the same as the other person.

If we adopt this narrow definition, then the results of these experiments do not support the empathy hypothesis, as indicated by three pieces of evidence. First, in the first experiment, the ratings of trait empathy did not significantly correlate with any of the dependent variables. Second, in the second experiment, having or not having information about the composer’s motivations did not make a difference in the intensity of the participants’ emotional reactions. Third, less than half of the participants who read the emotional narratives explicitly mentioned elements from them in the descriptions of their thoughts while listening to the music. And even among those who included elements from the provided narratives in their descriptions, the number of participants who explicitly mention the composer is a minority. If empathy involves making a distinction between self and other, and explicitly assuming that the feelings aroused in oneself belonged to someone else originally, then empathic responses were the exception, rather than the rule in these experiments.

This conclusion contradicts somewhat the findings of previous research into music and empathy. Vuoskoski and colleagues (2012) have found that trait empathy is related to more intense emotional reactions and enjoyment of sad music. Nevertheless, while this finding can be interpreted as indicating that listeners somehow empathise with the sad-sounding musicians (or virtual personae), it is also plausible that empathic people are simply more emotionally susceptible to displays of suffering in art, without necessarily engaging in imagining a real or virtual person undergoing the painful experience. Miu & Baltes (2012) found that listeners who adopted an empathic attitude towards an observed singer had stronger physiological responses and more intense induced emotions. However, these authors did not control the effect that watching the performer’s gestures could have in the empathic responses, and therefore, it is not possible to attribute the effects to the music only. Similarly, Wöllner (2012) found that participants with higher degrees of trait empathy were better at identifying the moments when the musicians of a string quartet were playing more “expressively”, but only in the visual and audiovisual versions of the stimuli. Moreover I consider Wöllner’s definition of empathy inappropriate. In his study, he regarded empathy as the ability to identify the intensity of an observed emotion, without considering the correct identification of that emotion, nor the induction of the same response in the observers.

To my knowledge, the only previous study where there is evidence of the mediation of empathic attitudes in emotional responses to music using auditory-only stimuli is the above-mentioned study by Egermann and McAdams (2013).These authors found that the ratings of the extent to which the participants empathised with the listeners were significant predictors of induced affect. This is an intriguing finding, but it does not settle the discussion, because their study does not provide all the information needed to establish empathy, according to the narrow definition proposed above. First, in Egermann and McAdam’s study, the participants’ induced emotions were only measured in terms of valence and arousal, so it is not possible to evaluate the extent to which a one-to-one correspondence between observed and induced emotion occurred. Second, the authors did not explore the participants’ thoughts and imagery while listening to the music, so it is not possible to know if they were imagining a real or virtual person whose feelings were being portrayed by the music. And third, the authors included musical stimuli with and without lyrics, making it impossible to know whether the participants reacted empathically to the stories portrayed in the lyrics, or to the musical sounds.

What can we conclude from this discussion about whether the results should be regarded as contagion or as empathy?

First, it is safe to conclude that in most cases, the results of these experiments corresponded to instances of contagion, not of empathy. This emotional contagion, however, does not correspond to an automatic, unmediated one-to-one-mirroring response as proposed by the BRECVEMA theory (Juslin, 2013b) and the Perception-Action model (Preston & de Waal, 2002). On the contrary, emotional contagion in these experiments was mediated by preferences, aesthetic appraisals, considerations of social affiliation, and by the activation of personal associations and culturally-shared semantic concepts. This observation suggests that just like previously found in mimicry responses to facial stimuli (Bourgeois & Hess, 2008), emotional contagion with music is always a contextualized response (Hess & Fischer, 2014; A. Miu & Vuoskoski, in press). Consequently, explanations of emotional contagion in terms of only simulation or mimicry cannot account for how bottom-up responses (driven by the perception of a stimulus) interact with previous knowledge (driven by the activation of semantic information about the music's meaning, its aesthetic value, and its social affiliation connotations), producing the emergence of an emotional response that matches the emotion expressed by the music.

A second conclusion from this discussion is that in order to advance in this line of research, adopting a rather "narrow" definition of empathy could prove to be more useful than adopting a wide one. This would allow us to clearly distinguish these two phenomena, and similar ones, like the experiences of subjectivity blending with music described by Clarke (2014). Moreover, it can be argued that only this level of theoretical clarity will allow us to answer important questions such as whether and how it is possible that music elicits empathic (or sympathetic) responses towards other human beings, and/or motivate altruist behaviours.

Future studies should also continue exploring how social affiliation connotations of music relate to, and are different from aesthetic judgements and enjoyment evaluations, using more direct manipulations to "disentangle" the effects of these factors (rather than statistical techniques like the ones used by Egermann and McAdams, 2013). One interesting possibility is to study the emotional responses to pieces of music that people experience as "guilty pleasures", that is, music that people experience as enjoyable, but at the same time, of little aesthetic value, and/or as potentially shameful in the eyes of the members of their social group. Using this type of stimuli would allow researchers to weight the relative influence that perceiving emotions in the music, and the activation of social affiliation considerations has in emotional contagion. Likewise, in order to better understand the relation between contagion and empathy to music, it would be necessary to test the extent to which contagion responses can be prevented from occurring if the participant cannot empathise with the person portrayed in the music. For example, would listeners still become infected by the sadness expressed by a piece of music, if they learned that the music was composed by a morally despicable person (e.g. a rapist, a terrorist, a thief)? In all of these cases, it will be necessary to combine the use of direct and indirect measures of affect, and open-ended questions, in order to have a complete picture of the implicit and explicit mechanisms involved in these phenomena.

8.8 Conclusion

The results of the two experiments that comprise this study suggest that embodied simulation of melodies and of the implied motor actions performed by the musicians do not play a significant role in the phenomenon of emotional contagion with music. They also indicate that emotional contagion with music is a mediated phenomenon where factors such as contextual information about the composer, appraisals of social affiliation, estimations of enjoyment, evaluations of aesthetic value, personal associations, and socially-shared semantic concepts influence the intensity and quality of the perceived and induced emotions that listeners experience. These mediating factors, however, should not be regarded as evidence that emotional contagion with music corresponds to a type of empathic response.

9. Conclusions, implications, and further directions

This thesis had three aims. First, to propose a constructionist theory to explain induction of musical emotions. Second, to test some of the empirical predictions derived from this theoretical framework. And third, to explore the validity of alternative techniques for measuring musically-induced emotions. In this final chapter I evaluate the extent to which the thesis achieved these aims, I discuss their implications, and the questions that future research will need to address.

9.1 Evaluation of my Constructionist Theory of Musically-Induced Emotions

The two most influential contemporary theories about the induction of musical emotions, Juslin and colleagues' BRECVEMA theory (Juslin, 2013a; Juslin et al., 2010; Juslin & Västfjäll, 2008), and Scherer and colleagues' Multifactorial Process Model (Scherer, 2004; Scherer & Coutinho, 2013; Scherer & Zentner, 2001), agree in the premise that emotional responses to music emerge from the interaction of factors in the music, in the listening situation, and in the individual. However, my examination of these theories in the second and third chapters revealed that their account of emotion elicitation comprises almost exclusively intra-individual processes. As a consequence of this psychological reductionist approach, these theories have neglected the cultural dimension of music as symbolic object, and the variability that is inherent to all emotional phenomena. The BRECVEMA theory, in particular, has two further limitations: it lacks details about how the mechanisms interact with each other, and it predicts that some of these mechanisms, on their own, can lead to the induction of discrete emotions, regardless of any consideration about how the personal and situational context in which music listening occurs interact with them.

The main challenge that this thesis took up was to propose a theoretical alternative that could overcome these limitations in the BRECVEMA and the Multifactorial Process theories. For this, I made use of the theoretical principles proposed by contemporary constructionist theories of emotion elicitation, (emphasising Barrett's Conceptual Act Theory (Barrett, 2006b), and I adapted them to the phenomena of musical emotions. To my knowledge, this is the first time someone has attempted to propose a theory of musically-induced emotions based on these principles. I consider these to be the main achievements of my proposal:

1. *My theory assumes a non-reductionist approach.* The central premise of my approach is that music is a cultural artefact that has effects on basic embodied processes of perception, and at the same time, on cognitively-sophisticated processes of meaning-making, which integrate personal and socially-shared referents. Hence, my theory integrates mechanisms beyond individual psychological processes. It provides detailed hypotheses about how musical emotions arise from the interaction of intra-individual mechanisms (e.g. neural resonance, motor simulation and goal-relevance), with mechanisms activated by the symbolic value of music (e.g. semantic concepts related to cultural connotations of music), and with mechanisms activated by situational and "extra-musical" factors (e.g. meaning of the listening situation, lyrics).
2. *My theory is well-suited for explaining emotional variability.* Since my theory proposes that emotional experiences and musical meanings are not determined by structural factors in the listener's biology nor in the acoustic characteristics of the music, it assumes that affective responses to music are characterised by their variety, and strives to explain it. My constructionist theory addresses emotional variation at several levels: it makes predictions about the processes that generate different levels of affective intensity (from mild and diffuse affective responses, to intense and full-blown emotions), predictions about the processes that produce qualitatively different affective responses (e.g. world-focused vs. self-focused, perceived vs. induced, tenderness vs. sadness, etc.), and predictions about how situational and cultural variations are associated with different types of affective experiences with music, within the limits of the affordances of the musical materials. Moreover, this emphasis in variability also

suggests that the principles outlined in my theory can be extended to understand how listeners build non-emotional meanings when they listen to music.

3. *My theory represents a unified theoretical framework.* My theory builds upon the proposals made by the BRECVEMA and the Multifactorial Process theories, by integrating several of the mechanisms they propose. However, unlike these theories, my proposal explains how the mechanisms interact with each other, shaping the person's affective responses.

4. *My theory is parsimonious.* Despite its apparent complexity, my theory can be regarded as a simplification of the proposals made by the BRECVEMA theory – which proposes eight mechanisms of emotion induction, each one associated with particular affective responses (Juslin, 2013a), and three types of coding associated with expression of musical emotions (Juslin, 2013c); and of the Multifactorial Process Model –which proposes six routes to emotion elicitation, including nine appraisal checks (Scherer & Coutinho, 2013). My theory, by contrast, integrates mechanisms into two subtypes, corresponding to the two core systems proposed by Barrett, 2006). First, mechanisms that produce changes in *core affect*, (which correspond to processes of perceptual organisation, involving process of bodily resonance, prediction and primitive affective evaluation). Second, *conceptual mechanisms* that transform core-affect into a variety of emotional and non-emotional experiences, (which correspond to processes of personal and cultural meaning-making, involving associative processing and cognitive appraisals). Moreover, my theory assumes that the same principles underlie experiences of perceiving emotions in the music, and the elicitation of emotion by music, and proposes that experiencing one or the other depends on mechanisms of attention deployment.

5. *My theory integrates bodily and mental aspects of affective response to music*. By embracing the proposals of embodied theories of cognition (Barsalou, 2003; Leman & Maes, 2014), and proposals about the embodied nature of the representations involved in affective processing (Wilson-Mendenhall *et al.*, 2011), my theory establishes links between bodily responses to music, such as patterns of muscular tension and motor entrainment (which tend to be primitive, non-conscious and involuntary), and "mental" responses, such as

personal memories and cultural connotations (which tend to be cognitively sophisticated, conscious, and susceptible to volition).

In addition to these five features, my theory answers the three essential questions that according to Moors (2009), every theory of emotion elicitation should answer:

The elicitation question arises from the observations that some but not all stimuli (in this case, not all musical stimuli) elicit an emotion; and that at times, the same stimulus leads to the emergence of an emotion, and on other occasion it does not.

Although the emergence of an emotional episode is caused by so many factors that it is virtually impossible to model them all, my theory suggests that three decisive factors make it more probable that a person experiences an emotion while listening to music. First, that personal-relevant associations are activated by the music or by other elements in the listening situation. Second, that the appraisals of goal relevance evaluate something in the music and/or the situation as pertinent enough for the person's goals. Third, that the person adopts a self-focused, deep mode of attention.

The intensity question refers to the observation that emotions vary in magnitude from no intensity to very high intensity.

The answer to this question in my theory is similar to the previous one. The more a musical event evokes personally-relevant associations, and is evaluated as central to the person's goals, the more intense the emotional reaction will be. Additionally, variations in the intensity of affective experiences with music can also arise from changes in core affect produced by bodily states, such as variations in arousal induced by physical exertion (as demonstrated by Dibben, 2004).

The differentiation question concerns the variability in emotional quality, that is, the observation that emotions vary in valence (pleasurable and unpleasurable), and in type (e.g. joy, sadness, pride, etc.).

According to my theory, variations in valence arise in part from quick appraisals of the goodness/badness specified by the musical materials, but valence is also constantly shaped by other factors in the music, the person, and the situation. Thus, associative processes such as conditioning, the activation of semantic concepts, and the evocation of personal memories all contribute to produce changes in levels of pleasure and displeasure. Additionally, processes of appraisal, including evaluations of goal relevance, control, and aesthetic judgements, have an impact on valence.

Similarly, the variability in the type of emotions that music can elicit depends on complex interactions between the fluctuations of core-affect induced by music, and the way those fluctuations are shaped into emotional and non-emotional experiences by associative and appraisal mechanisms. This variability, however, tends to be restricted by the variations in core affect specified by the musical materials.

9.1.1 Similarities and differences with other theories

It is necessary to acknowledge that my proposal does not constitute a completely new theory with radically different constructs and premises. On the contrary, there are probably as many points of encounter as there are differences between my theory and the BRECVEMA and the Multifactorial Process Model. I summarise the main ones below.

9.1.1.1 The BRECVEMA and the Multifactorial Process theories:

To a great extent, my theory consists of a reorganisation of the mechanisms proposed by the BRECVMA and the Multifactorial Process theories. However, I also include some mechanisms that are not present in those frameworks, such as the mechanisms of neural resonance, the learning mechanisms of mere exposure and enculturation, the activation of semantic concepts, and the activation of associative processes due to the influence of extra-musical information. Furthermore, unlike the BRECVEMA theory, (but like the Multifactorial Process Model), I explicitly include appraisal mechanisms.

One of the main differences with the BRECVEMA theory is the premise, central to my proposal, that emotions always involve elements of personal relevance. This assumption implies that mechanisms that only produce low-level affective responses such as rhythmic entrainment and musical expectancy cannot lead to the induction of full-blown emotions without the contribution of associative processes. Therefore, unlike the BRECVEMA theory, I predict that no mechanism can lead to the induction of emotions on its own. (Except the episodic memories mechanism, which directly involves the reinstatement of past emotional experiences).

My theory includes the notion that our brains and bodies engage in a sort of "resonance" with the music. Even though this proposal keeps some similarities to the theory of emotional contagion proposed by the BRECVEMA theory, the two concepts are fundamentally different. The notion of resonance that I propose should be understood in terms of a neural and bodily attunement to the characteristics of the music, which involves processes of prediction and evaluation of the significance of the stimulus for the person's well-being. This resonance is constantly modulated by conceptual mechanisms, producing a variety of emotional and non-emotional responses even when the music is perceived by the listener as expressive of particular emotions. The theory of emotional contagion proposed by Juslin and colleagues, by contrast, regards contagion as a process of "internal mimicry" of a basic emotion expressed by the music, which leads to the induction of the same basic emotion in the listener (Juslin & Västfjäll, 2008, p. 565). Moreover, although this theory acknowledges that musical emotions are influenced by contextual and personal factors, it does not make any predictions about how emotional contagion is mediated by other mechanisms, giving the impression that the process of contagion is automatic and unavoidable.

There are many similarities between my approach and Scherer's Multifactorial Process Model. Besides the already-mentioned inclusion of appraisal mechanisms in my proposal, there is a resemblance between Scherer and Zentner's classification of the mechanisms into peripheral and central (2001), and my proposal of organising them into core-affect and conceptual mechanisms. For Scherer and Zentner, the peripheral category includes effects of music on the autonomous nervous system, rhythmic entrainment, and facilitation of pre-existing emotions, whereas the central category includes appraisals, memory, and empathy. By contrast, my proposal of core-affect mechanisms includes primitive appraisal mechanisms, and details about how bodily resonance to music occurs, which are not present in their theory. Additionally, unlike their "central mechanisms" category, which constitutes a different route to emotion elicitation, the conceptual mechanisms category I propose is inherently related to the core affect category. In my view, conceptual mechanisms shape core affect fluctuations, and therefore, both types of mechanisms are always active in the emergence of an emotional episode.

A further difference between my approach and the Multifactorial Process Model is that I do not explicitly include the facilitation and empathy mechanisms in my proposal, because I regard them as special cases that can be explained by the processes I included in the rest of the theory. Thus, instances of facilitation of emotion are simply occasions where the combination of musical and contextual factors make the affective value of the situation be represented in several components at the same time (motor, somatic, cognitive, motivational, subjective feeling), producing the emergence of a discrete emotional episode (Clore & Ortony, 2008). Instances of empathy, on the other hand, can be regarded as situations where the listener focuses her attention on the (real or imagined) musician(s), and activates associative mechanisms such as narratives about the musician's feelings, thus adopting an empathic attitude that increases the probability of undergoing an emotional episode.

Another subtle, but important difference between my approach and the Multifactorial Process Model is that my theory, in line with the claims of the Conceptual Act Theory, puts more emphasis on associative mechanisms than on rule-based appraisals. One reason for this is that constructionist approaches assume that emotion elicitation rarely occurs because the evaluation of a completely new stimulus triggers a process of appraisal, as proposed by appraisal theories such as Scherer's CPM (Scherer, 2013). By contrast, theorists such as Russell (2003) and Barrett (2006b) emphasise that the previous context of the organism biases the ongoing evaluation and adaptation to the environment that is constantly reflected in core affect. Therefore, from this point of view there is never an affective-less "starting point" before an emotion is elicited (not even in the context of an experimental laboratory). This makes the sequence of appraisal checks that are central to Scherer's theory unnecessary, because the organism has already "pre-appraised" the meaning of the situation even before the new stimulus is encountered, and this previous affective context biases the perception of the new stimulus from the very beginning (Lebrecht *et al.*, 2012). A second reason for my emphasis on associative processing is that in my theory, I have adopted Barrett's proposal that emotions involve the reinstatement of information from similar past experiences which becomes tailored to the present situation. This again implies that much of the information that appraisal checks provide in Scherer's model is already contained in the information that becomes activated by the associative processes.

A final difference with the Multifactorial Process Model is that my adaptation of the principles of constructionist theories implies that even everyday "regular" emotions are not exclusively determined by rule-based appraisals, and that musical emotions can be explained by ordinary processes such as perception, affective evaluation, and conceptual processing. Moreover, the consensual definition of emotion that I proposed in the first chapter, and the inclusion of appraisals in my theory also imply that musically-induced emotions involve evaluations of personal relevance, just like ordinary, “utilitarian emotions” (Scherer, 2004). All of these considerations make the distinction between affective responses to aesthetic stimuli, and affective responses to other stimuli, circumstantial. In consequence, I do not deem it necessary to establish musically-induced emotions as a special “aesthetic” category, as Scherer has proposed (2004). I consider that establishing such a boundary increases the risk of isolating research into musical emotions from the developments of general affective science, to the detriment of both.

9.1.1.2 Other theories of induction of emotion by music:

Two other theories of induction of affective responses to music deserve mention because of their similarities to my proposals: Thompson and Coltheart’s dual processing proposal (2008), and Flaig and Large’s theory of dynamic musical communication of core affect (2014).

The first of these theories appears in the comments section to Juslin and Västfjäll’s seminal paper from 2008, where Thompson and Coltheart suggest that the mechanisms proposed in the main paper should be organised into two categories: *signal detection mechanisms*, which induce emotion by “directly detecting emotive signals in music” (including brain stem responses, expectancy, and evaluative conditioning), and *amplification mechanisms*, which amplify (i.e. intensify) the output of signal detection mechanisms (including episodic memories, and visual imagery, and emotional contagion) (Thompson & Coltheart, 2008, pp. 597–598). There is a similarity between the notion that signal detection mechanisms tend to be automatic and focused on the music, and my proposal of core-affect mechanisms as perceptual mechanisms inevitably activated by music listening. However, not only do I provide many details about how this dynamic occurs which are absent in Thompson and Coltheart’s proposal, but also my proposal about the role of conceptual mechanisms goes beyond a mere amplification of an emotion that has already been generated. In my theory, conceptual mechanisms *transform* the musically-induced fluctuations in core affect by making them more personally relevant, specific, and intentional (i.e. providing them an object).

Flaig and Large’s theory of communication of core affect (2014) proposes that the patterns of neural resonance activated during music perception can be disrupted by the violation of musical expectancies in the musical material, leading to modulations of core affect. As I noted in chapter 5, my theory of how music perception emerges from patterns of neural resonance is based on proposals such as Large's (Large & Almonte, 2012; Large & Kolen, 1994). However, my identification of sources of fluctuation in core affect includes many mechanisms that Flaig and Large do not consider in their proposal. Moreover, the complete absence in their theory of mechanisms that provide affective responses to music with elements of personal, situational, and cultural specificity, make their proposal a psychological reductionist one, and therefore, very different from my approach.

9.1.1.3 The Conceptual Act Theory:

Evidently, this comparison of my theory with others would not be complete without evaluating its differences with Barrett's Conceptual Act Theory (Barrett, 2006b), the main theoretical source on which I based my proposal.

The main difference between my proposal and Barrett's, is the explicit inclusion of appraisal mechanisms in my theory. One of the strongest criticisms that constructionist approaches like Barrett's (2006b) and Russell's (2003) have received, is that they do not specify how the changes in core affect come to happen, and in consequence, the identification of the eliciting object of the emotion seems to be a matter of interpretation or decision by the individual after the changes in core affect have happened (Deonna & Scherer, 2009; Scarantino, 2015). Although it could be argued that this criticism applies more to Russell's than to Barrett's approach (see section 4.2.2 in chapter 4 for more details), I sympathise with the observation that these theories should provide more details about the processes that generate changes in core affect.

With these considerations in mind, I strived to specify the processes and mechanisms that produce changes in each of the two basic dimensions of core affect, a decision that distances my proposal from Barrett's, and places it near appraisal theories[31]. However, at the same time, unlike appraisal theories, I suggest that appraisal processes are only one of the components involved in this dynamic, and probably not the main one.

---

[31] These similarities between my theory and appraisal theories should not come as a surprise, if we consider that in general terms, constructionist and appraisal approaches have many elements in common, and the disagreements between them are not as large as the disagreements they both have with Basic Emotion theories (Brosch, 2013; Gross & Barrett, 2011).

Additionally, since I do not make assumptions about the chronological order in which appraisals occur, and I propose that the evaluations of the affective value situation tend to be largely produced by associative mechanisms, my proposal shares the assumption of other constructionist approaches such as Clore and Ortony, where appraisals are regarded as components of emotional experiences, but not their cause (Clore & Ortony, 2013).

9.2 Evaluation of empirical findings

The constructionist theory of musically-induced emotions I presented is undeniably ambitious and encompassing. Therefore, I explored just a few of the hypotheses derived from this framework in the empirical studies. The decision as to which phenomena to explore was motivated by the opportunity they represented to test the central claim that core affect and conceptual mechanisms produce different types of variation in the listeners' affective experience, and modulate each other producing a variety of emotional responses. Thus, the first and second experiments studied the core-affect mechanisms of rhythmic entrainment and embodied simulation, which involve engaging in explicit or implicit motor and vocal responses to music. And the second and third experiments studied how embodied simulation is modulated by associative mechanisms such as semantic concepts and extra-musical information. In this section I summarise the main conclusions from the empirical studies of the thesis, and I analyse their implications for my theory.

9.2.1 Experiment 1: Rhythmic Entrainment and Pleasure

The first aim of this experiment was to study the effects of bodily movements while listening to music on the elicitation of affective responses. For this, I compared a group of participants who listened to rhythmic musical stimuli while tapping along with their foot, with a group of participants who listened to the same stimuli while staying still. The second aim was to replicate the findings of Witek *et al.* (2014) in which listening to music with intermediate syncopation levels was associated with more intense experiences of induced pleasure, as compared with music with low and high syncopation levels. The findings indicated that, contrary to the prediction, listening to the music while engaging in motor entrainment, compared to listening while staying still (which involves perceptual but not motor entrainment), did not have a positive effect on the participants' ratings of core affect. In contrast, the prediction about the association of intermediate syncopation levels with higher ratings of pleasure was supported by the data.

In spite of the methodological limitations that might have caused the partially null results, the discussion of the results of this experiment showed the fruitfulness of adopting the view that the phenomena of rhythmic entrainment, musical expectancy, and motor planning arise from the same perceptual principles. According to this interpretation, rhythmic entrainment emerges from the tendency to synchronize motor responses to oscillating events in the music (Colling & Thompson, 2013). This synchronization involves a process of prediction that generates subjective feelings of expectancy and urges to move along to the music. In turn, these predictions and motor planning responses can be disrupted by syncopated events, generating fluctuations in core affect (Flaig & Large, 2014), which as my findings suggested, are experienced as changes in pleasure and tension arousal (but not in energetic arousal). Additionally, engaging in overt synchronized movements to the music involves additional mechanisms of prediction-correction that produce subjective experiences of difficulty synchronizing with the music. The results of the experiment suggested that these feelings can be so powerful that they can overrun the pleasure derived from listening to music with intermediate levels of syncopation.

One important implication of these findings for my theoretical proposal, is that contrary to what I speculated in chapter 5, the phenomenon of rhythmic entrainment (at least in the modality of perceptual entrainment) can produce changes in the valence component of core affect, and not only in the arousal component. Thanks to the involvement of quick and implicit processes of appraisal, stimuli with intermediate levels of syncopation generate an ideal level of tension between the confirmation and the violation of predictions about where the next rhythmic event will occur, and this in turn generates pleasurable urges to move in time with the music (Witek *et al.*, 2014). Future studies should explore how musical stimuli that contain very few violations of expectancies (e.g. polka music) can still generate action tendencies to engage in motor entrainment, and positive changes in valence and arousal.

Although in this experiment I did not explore the extent to which the affective responses of the participants could be better described in terms of diffuse fluctuations of core affect, or as discrete emotions, one observation suggests that the participants' responses did not go beyond fleeting experiences of changes in valence and arousal. I speculated that the null results were in part due to the fact that the participants did not find the drum-breaks “musical enough” (i.e. they perceived them as artificial, or lacking expressivity). Consequently, it can be assumed that the lack of personally-relevant elements in the music and the listening situation, prevented the re-instatement of past emotionally meaningful simulations, and therefore, the participants’ responses to the stimuli were limited to barely noticeable variations in core affect. A second interesting implication of this finding is that it highlights the importance that aesthetic appraisals of the quality of the music have in the elicitation of emotional responses. I return to this point later.

9.2.2 Experiments 2 and 3: Embodied Simulation, Emotional Contagion, and Extra-Musical Information

The study comprised by the two experiments reported in chapters 7 and 8 investigated the extent to which emotional contagion with music is engendered by embodied simulation, and by the activation of semantic concepts, two mechanisms associated with the core affect level of processing, and with the conceptual level, correspondingly.

I examined two hypotheses about the type of embodied simulation involved in emotional contagion with music. The first was based on the theoretical suggestions I made in chapter 5, about how music perception involves processes of motor planning (i.e. motor simulation); and on Scherer and Coutinho’s (2013) proposal that observing the motor expressions of the musicians can induce motor mimicry, which in turn can lead to contagion responses. Thus, I predicted that if this type of mimicry was facilitated (by asking participants to either mimic or imagine themselves making the implied movements made by the performers), this bodily involvement with the music would generate higher levels of arousal, and therefore, more intense emotional responses. The competing hypothesis, based on a hypothesis from the BRECVEMA theory (Juslin & Västfjäll, 2008), predicted that asking participants to mimic the music’s melody would have the same facilitating effect, because this mimicry of acoustic features associated with the expression of a basic emotion would lead to the induction of the same emotion in the listener.

The results of these experiments gave little support to these hypotheses. The results suggested that these simulation mechanisms do not have a significant effect on the intensity of the emotions that people experience while listening to music. In line with the theoretical proposal I proposed, I interpreted this finding as evidence that embodied simulation could only have emotional effects if the listeners map the mimicked movements onto emotional meanings, (for instance, by experiencing the violinist's actions necessary to make a crescendo as an intensification of feelings of power or anger). However, this facilitating effect was not observed when participants read emotional descriptions of the music. This suggests that contrary to the claims of my theoretical framework, the embodied processes that generate musical percepts are considerably independent of the associative processes that enrich the listening experience with emotional meanings.

An alternative explanation of the finding that embodied simulation did not facilitate the elicitation of emotion, is that we do not really simulate the specific implied movements and melodies made by the musicians when we listen to music. This interpretation suggests that the activation of pre-motor brain areas that has been observed in neuroimaging studies (Brown & Martinez, 2007; Chen *et al.*, 2008) corresponds to representations of abstract notions of movement, tension, release, etc. that are not necessarily associated with a single sensorimotor modality. This possibility, proposed by embodied metaphor theories such as Johnson and Larson (2003) implies that mimicking the specific movements and melodies performed by the musicians is not only difficult, but to some extent unnecessary, because the type of motion that is specified by music is better captured by movements similar to those observed in spontaneous dance (i.e. moving parts of the body in ways that represent patterns of as ascend, descend, acceleration, etc. specified by the music). This is an interesting possibility that should be explored in future investigations into the relationship between bodily movements and music, such as the ones conducted at the University of Jyväskylä (e.g. Luck *et al.*, 2014). However, to my knowledge, no experiment so far has addressed the question of how these mappings of musical patterns onto movements acquire emotional significance, and contribute to the induction of emotional responses.

Both experiments supported the hypothesis that personal associations, cultural connotations of music and extra-musical information shape the participants' affective responses producing a variety of emotional experiences. In my interpretation of the results I argued that the main mechanism behind this effect was the activation of semantic associations, and that the visual imagery mechanism proposed by the BRECVEMA theory was secondary to these associations. Admittedly, however, these experiments provide only partial evidence for this claim. Stronger evidence for the independence of these two mechanisms could be obtained from future experiments that isolate both processes, by for example, asking participants to listen to the music while observing a non-emotionally meaningful video (preventing the generation of idiosyncratic visual imagery and the construction of narratives), and examining if their emotional responses still suggest that the music activated semantic concepts that biased their perception and induction of emotions.

The finding that semantic concepts mediated the participants' responses supports my claim that emotional contagion is not exclusively determined by the acoustic characteristics of the music, or their resemblance to the expression of an emotion, but mediated by personal and socially shared associations. Contrary to the claims of the BRECVEMA theory (Juslin & Västfjäll, 2008), the participants perceived and underwent basic and non-basic emotions biased by the semantic information they had access to. Furthermore, it was observed that perceiving an emotion expressed by the music did not always correlate with the induction of the same type of emotion in the listener. The BRECVEMA theory (e.g. Juslin, 2013c) would probably explain these results arguing that listeners tend to perceive basic emotions in music (e.g. sadness), which become differentiated by virtue of associative coding, producing the observed variety (e.g. nostalgia, calm, etc.). My interpretation, in contrast, is that it is more parsimonious –and more consistent with the variety of meanings that music acquires in different contexts-, to assume that perception of music's expressivity is not inherently organised into discrete emotional categories. Instead, perception of musical expression (much like perception of vocalisations) depends on the detection of variations in arousal and valence specified by the music, which can acquire a variety of emotional and non-emotional meanings depending on the presence of relevant semantic cues in the listening situation.

In addition to the activation of semantic concepts, these experiments revealed that aesthetic evaluations of the music were a crucial mediator in the participants' responses. On many occasions, these evaluations determined the difference between having a positive and a negative emotional response to the music, or even between having an emotional reaction and reacting with indifference. This finding suggests that contrary to what theories of induction of musical emotions have assumed, it is likely that appraisals about the music's aesthetic value (and the extent to which it facilitates or obstructs the listeners' present goals) play a central role in shaping the quality and intensity of emotional responses to music. The role of aesthetic appraisals (which Juslin and colleagues have started to explore recently: Juslin & Isaksson, 2014) represents an interesting avenue for future research.

9.2.3 Other Implications of the Empirical Findings for my Theory

Two of the constructionist theories on which I based my proposal have suggested that core affect is constituted by the dimensions of arousal and valence (Barrett, 2006b; Russell, 2003). However, I suggested in Chapter 5 that it is possible that musically-induced variations of affect can be better described with further dimensions. Consequently, I asked the participants to report their feelings along the tense and energetic arousal dimensions in all the empirical studies; and I included questions related to the power dimension in the second and third ones.

The participants' ratings of tense arousal and energetic arousal in all the experiments were highly but not perfectly correlated, suggesting that listeners can readily differentiate these two dimensions of their experience, and that the two dimensions relate to different aspects of their affective experience. It is also likely that these variations of tense arousal and energetic arousal are associated with variations in different musical parameters. For example, it is conceivable that whereas variations in energetic arousal may be related to variations in loudness and tempo, variations in tense arousal may be related to variations in harmonic tension and violations of musical expectancies. Identifying these correspondences, and the way the variations in the three dimensions are mapped onto discrete emotions constitute interesting avenues for future research.

Regarding the power dimension, the results from experiments 2 and 3 suggest that this dimension may be particularly relevant when the music is perceived as expressive of anger and/or fear. For instance, it was observed that participants who perceived the music as expressing pride or power, (but not those who perceived it as expressing fear) tended to report feeling triumphant or strong themselves. However, since I did not include items exploring the other end of this dimension (i.e. perceptions that the music expressed weakness, and induced feelings of impotence), my exploration of the power dimension is incomplete. Future research should investigate the validity of this dimension in listeners' experience to music. This exploration should include the identification the musical parameters associated with variations in this dimension, the extent to which this dimension can be subsumed by variations in tense and energetic arousal; and the dependence of this dimension on the type of listening attitude that the person assumes towards the music (e.g. experiencing from first person perspective vs. experiencing from a third person perspective). Exploring this musical power dimension can help us understand better why some people (particularly young subcultures) are attracted to music that sounds aggressive and/or scary (e.g. heavy metal, punk rock, gangsta rap). Thus, describing the phenomenology of these experiences can on the one hand, help us understand how musically-induced “anger” is different from everyday anger (similar to what researchers have found recently about musically-induce sadness, e.g. Van den Tol & Edwards, 2011; Vuoskoski, Thompson, McIlwain, & Eerola, 2012). On the other hand, it can help us elucidate how this type of music facilitates (or not) negative attitudes, moods, and behaviours such as violence, depression and self-harming.

The central claim in my theoretical proposal is that emotional responses to music only occur when the diffuse core affect induced by perceptual mechanisms is transformed into a full-blown emotion by the contribution of conceptual mechanisms. What evidence is there for this claim in the empirical studies of the thesis? Admittedly, the evidence they provided for this claim is indirect, because none of the experiments attempted to isolate, or to prevent the activation of conceptual mechanisms in order to examine their effects. In fact, since the Conceptual Act Theory predicts that these type of mechanisms are always “on” in every waking moment producing a variety of mental states (Barrett, 2009, p. 1292), it is practically impossible to completely block their effects. However, the second and third experiments did provide evidence that the listeners’ affective responses to the music varied influenced by mediating factors such as their aesthetic evaluations, cultural and personal connotations activated by the music, and extra-musical information provided in the form of programme notes.

Did the experiments provide evidence for the alternative explanation, proposed by the BRECVEMA theory, that single mechanisms induce full-blown emotions? Perhaps it could be argued that the small effect of the manipulation of extra-musical information in the third experiment suggests that the descriptions could only bias emotions that were already induced by the music. This explanation, however, seems unlikely given the variety of emotional responses observed across the experiment, even in the group of participants who did not read an emotional description before listening to the music. At the same time, the finding that the extra-musical information had a small effect suggests that musically-induced variations in core-affect are the main factor that generates affective responses to music. In other words, unless powerful personally-relevant mechanisms are activated (such as the appraisal that the music blocks an important present goal, or the evocation of specific episodic memories), the reaction of the listener will tend to coincide with the variations of core-affect specified by the music. (Some evidence for this conclusion has been provided in experiments mapping variations of psychophysiological responses and core affect to musical parameters, e.g. Coutinho & Cangelosi, 2011; Russo, Vempala, & Sandstrom, 2013).

9.3 Evaluation of research methods

The methods implemented in this research project were based on three assumptions of the constructionist theory I proposed:

1. Having an emotion consists of a process of meaning-making, in which we construct affective meaning about the present situation, integrating information from the eliciting event, from the context, from past similar experiences, and from our bodily and psychological state.
2. Many of our affective responses to music do not correspond to full-blown emotions, but to more basic, fleeting and world-focused fluctuations of affect.
3. The presence of narratives, emotional labels, and other contextual information can transform these diffuse affective responses into discrete emotional experiences.

One methodological implication of these assumptions is that understanding people's affective responses to music involves obtaining objective data from carefully controlled stimuli (i.e. using experiments), but also obtaining qualitative data about the way they elaborate the meaning of the musical event. These assumptions also suggest that using ambiguous musical stimuli can help explore how emotional meanings and experiences are constructed, rather than directly determined by the musical stimulus. Additionally, these theoretical premises also entail that traditional techniques such questionnaires of emotional adjectives should be complemented by indirect measures of induced affect, and by techniques that tap into dimensions of affective experiences that are not optimally described by emotional adjectives, such as action tendencies.

9.3.1 Indirect Techniques Based on the Perception of Facial Stimuli

The rationale behind this type of technique is that affective states have consequences for cognitive processing in a mood-congruent fashion (Bower, 1981). Thus, based on the findings of Niedenthal and colleagues that induced affective states bias the perception of ambiguous and of morphing facial expressions (Niedenthal *et al.*, 2001, 2000), I decided to implement this type of technique in two of the experiments.

In the first experiment I used ambiguous facial expressions. For this, I created "blended" facial pictures that contained both positive and negative expressive elements, and asked the participants to judge the valence experienced by the person in the photo. The results were not encouraging. Although the data indicated that the majority of the stimuli were perceived in the predicted mood-congruent fashion, most of the correlations between these scores and self-reports of valence were small and nonsignificant. Moreover, there was a large variation between subjects, and the results suggested that the mood-congruence effect did not last more than a few seconds.

Since the limitations of the ambiguous-faces technique could have at least in part be due to the fact that I used stimuli developed by myself, in the second experiment I used stimuli that had been validated in a previous experiment (Niedenthal *et al.*, 2001). This technique involves asking participants to observe videos displaying faces that change from a positive to a negative expression, and to detect the point where the positive expression is no longer present in the face. It was predicted that the more the participants were in a positive affective state, the earlier they would detect the change from a positive expression into a negative one. Once more, the results did not show robust and reliable patterns. The participants' ratings exhibited large inter-subject variability, and the predicted correlations between the scores in the indirect technique and the scores from the questionnaires of induced emotion were the exception rather than the rule.

Several conclusions can be extracted from the exploration of these two techniques. First, these techniques seem promising, particularly because they can potentially circumvent some of the problems associated with asking participants to report their affective states using verbal labels, such as demand characteristics, limitations in self-reflective abilities, self-presentation biases, and translation issues (Juslin et al., 2010; Zentner & Eerola, 2010b). However, they also present several drawbacks which suggest that, in their present form, they do not represent reliable measures, as described below.

First, it is not clear the extent to which the participants perform this type of task based mainly on affective processes. The task that they have to perform is too atypical: the ambiguous faces are not only ambiguous, but also strange (they do not look like natural expressions), and the morphing faces tend to change in ways that normal faces would not. These characteristics of the stimuli create additional demands on the participants, who probably end up using rational, rather than spontaneous affective strategies to perform the task, thus eliminating the intended effect. Future research should explore if this difficulty can be overcome by asking the participants to perform the perceptual task as quickly as they can.

Second, not only was there a large observed inter-rater variability, but also some of the stimuli seemed to show the expected effect better than others. This implies that investigators wishing to use these techniques have to spend considerable time creating and validating the set of stimuli that they use.

Third, in their present form, these techniques only inform about the participants' valence, but not about other dimensions of core affect, or about the presence of specific emotions.

Finally, just like any other indirect technique, using these techniques creates additional problems when the information they provide is contradictory with the information provided by explicit self-reports of affect, (for instance, when the participant reports feeling well, but the indirect technique indicates the presence of negative valence). Which measure should the researcher trust when they find this type of mismatch? Could it be possible that they are both correct, but they respond to different aspects of affective processing, one implicit and world-directed, and one explicit and self-reflective?

9.3.2 Questionnaire of Action Tendencies, Subjective Feelings and Appraisals

The consensual definition of emotion I proposed in the first chapter describes it as made up of different components: cognitive, somatic, motor, motivational, and subjective feelings. Most psychological research on musical emotions (and emotion in general) has measured the feeling component in terms of discrete emotional adjectives intended to capture the whole subjective experience of the person. However, it can be argued that the feeling component is not exhausted by assigning an emotional label to the experience, because it also contains subjective sensations associated with the other components, such as urges to behave in a certain way (motivational component), bodily feelings (somatic and motor components), and ideas about the meaning of the situation (cognitive component) (Scherer, 2009a, p. 3467).

Based on these considerations, I decided to develop a questionnaire that measured these other dimensions of the feeling component, which have been previously unexplored in music psychology research[32]. The questionnaire consists of 15-items asking participants to rate their experience in terms of action tendencies, bodily sensations, and appraisals.

The results from the second and third experiments showed coherent patterns of correlation between the answers to this questionnaire, and the questionnaires based on emotional adjectives. As expected, the informative value of the items varied according to the characteristics of the musical piece, and the type of emotions it evoked. For instance, the scores in the item “I felt like dancing” were more relevant when participants listened to a joyful-sounding piece, than when they listened to an angry-sounding one, and the scores of the item “I felt like attacking something” showed the inverse pattern. Taken together, the results from both experiments suggest that this questionnaire constituted a valid measure of the participants’ affective experience.

This instrument represents a potentially useful technique for research into musical emotions. Its main strength is that it circumvents one of the most important difficulties associated with demand characteristics in studies of musically-induced emotions, namely, the tendency of participants to report emotions they perceived, rather than emotions they underwent. With the use of this questionnaire, the researchers can make sure that, for example, when a participant reports feeling “sad”, they are also experiencing associated feelings such as “feeling like crying” or “feeling like I needed to be comforted”.

Evidently, this instrument also has some limitations, too. First, it relies on self-report, and therefore, it is affected by the participants’ ability to reflect on their subjective experiences. Second, since the answers to the items in the questionnaire cannot be mapped, one-to-one, onto discrete emotions, this questionnaire complements, rather than replaces, questionnaires that use emotional adjectives to measure induced

---

[32] I recently discovered that a team of researchers led by Klaus Scherer at the University of Geneva have started to work in the development of a similar instrument, but they have not produced any publications about it yet.

emotions. And finally, it is likely that the items in the present version of the questionnaire do not exhaust all the possible (or typical) action tendencies, somatic feelings, and appraisals evoked by music listening. Future research should continue exploring the necessity of including other in from the questionnaire, and evaluating the validity of the instrument as a whole.

9.3.3 The Use of Ambiguous Musical Stimuli and Qualitative Information

As reviewed in Chapter 3, most experimental research into perception of emotional expressions has used portrayed facial and vocal stimuli that look or sound like exaggerated expressions that do not resemble natural ones. Similarly, most music psychologists researching musical emotions have used musical stimuli that maximise the probability that the participants perceive or undergo the target emotion, and therefore their musical stimuli tend to sound like musical stereotypes.

In contrast with this tendency, in the second and third experiment I decided to use music that had an emotionally ambiguous character. This decision was based on the consideration that although maximising the power of the stimuli has methodological advantages, using exaggerated expressions prevents us from understanding how people construct emotional percepts in everyday music listening circumstances, (where the music can be more ambiguous, and embedded in situations where lyrics, visual narratives and other contextual cues are usually present). Additionally, consistent with this aim of understanding the processes of meaning construction, I included open-ended questions about what the participants thought while listening to the music.

The results of the experiments suggest that these two strategies were successful. The combination of the use of ambiguous musical stimuli and the collection of qualitative data from the open-ended questions allowed me to learn how musical emotions can be at the same time restricted by the variations of core affect specified by the musical materials, and influenced by associative processes such as personal memories, cultural connotations of the music, and written descriptions of the music.

Evidently, these methodological strategies also have some disadvantages. The ambiguous character of the music makes it difficult to know exactly which musical parameters are associated with variations in the dimensions of core affect; and it can also reduce the effect of music on the participants' affective responses, making it difficult to extract clear conclusions. Obtaining qualitative information has the obvious disadvantage that it tends to take long time to analyse it. Additionally, the participants' reports of what they thought while listening to the music is limited by their abilities of self-reflection and recall. And finally, it can be argued that the value of this information is always qualified by the consideration that many cognitive and affective processes are implicit, and therefore, not susceptible to detection by techniques based on self-report.

9.3.4 The Use of Web-Based Experiments

The third experiment was carried out using a web-based platform instead of a laboratory setting. The results suggest that overall, using this technique was a fruitful strategy. It enabled the recruitment of a large number of participants from many nationalities and cultural backgrounds in a very short period of time (less than two months from the moment the experiment was launched). It is also probable that the problems associated with the awkwardness and embarrassing feelings aroused by the presence of the researcher during the second experiment were eliminated by the fact that with this web-based platform the participants were able to do the experiment in their own time, and in places where they felt at ease.

However, compared to a traditional laboratory-based experiment, this web-based methodology had the disadvantage of reduced experimental control. This involved collecting data from many participants, only to have to exclude a large proportion of them who did not follow the procedure correctly. However, in spite of these limitations, using this web-based technique represents an attractive alternative for studies on music and emotion, especially when one of the objectives is to gather conclusions with greater external validity.

9.4 Implications, future directions and concluding remarks

During this chapter I have suggested several avenues for future research. In this final section, I focus on the main themes that have emerged throughout this discussion.

1. *The relationship between overt bodily movement to music and induced emotions.* There is accumulating evidence that suggests that overt and implicit motor responses play a substantial role in perception of music (Maes, Leman, Palmer, & Wanderley, 2014; Phillips-Silver & Trainor, 2008). However, there is comparably

much less evidence about how these bodily movements evoked by music contribute to the induction of emotional experiences. Although it seems obvious that moving in time with music is associated with pleasurable experiences, (as can be inferred by the close association between music and dance), this relationship should not be taken for granted. For instance, the results of the first experiment indicate that engaging in motor entrainment by itself is not enough to induce changes in valence.

Future research should investigate the extent to which the effects of bodily movements on induced musical emotions depend on factors such as the presence of expressive elements in the music, the synchronization of the listener's movements with musical elements, whether these movements are influenced by semantic connotations activated by the music, and whether there are some types of music which people prefer to listen to without moving.

2. *The role of internal embodied mechanisms such as motor simulation and embodied metaphors.* The results of the second and third experiments suggest that embodied simulation of the implied motor actions performed by the musicians does not facilitate the induction of musical emotions. However, this hypothesis was tested in the context of musical pieces that the listeners were not familiar with. Is it therefore possible that the effect of this internal motor mimicry is only present when the participants are familiar with the piece? Would the expected effect of expertise (i.e. the ability to play the piece) be observable in this situation? This is an interesting possibility that should be explored in future research, including the question of how these simulation processes occur in listeners who cannot play any musical instrument.

   Alternatively, if we disposed of the notion that embodied simulation is involved in musical emotions, how could we reconcile this with the evidence of the activation of pre-motor brain areas from neuro-imagining studies? Should we interpret this as evidence of the activation of supra-modal embodied metaphors? Carrying out research to decide between these two hypotheses (embodied simulation vs. supra-modal metaphors) can help us advance our understanding of these embodied processes which has consequences not only for music psychology, but for general theories of cognition and affect.

3. *The influence of extra-musical information.* Most music that people listen to in everyday circumstances contains or is embedded in “extra-musical” elements such as lyrics, videos, photographs, social events, the presence of other listeners, etc. It is likely, as suggested by the results of the third experiment, that all of this contextual information has effects on the listeners’ emotional experiences, but so far, no research programme has tried to map these influences in a systematic manner.

   The research I reviewed in section 5.3.2 of chapter five suggests that when music is paired with visual and verbal narrative, both sources of meaning interact producing a variety of perceptual effects, but little is known about how these two sources of meaning interact producing effects on listeners’ induced emotions. Hence, future research should explore how different types of contextual information presented along with the music (visual, verbal, etc.) interact with the material properties of the music, shaping the listeners’ emotional responses, and the role that the activation of mechanisms such as visual imagery and the activation of semantic knowledge play in this phenomenon.

4. *Empathic responses to music.* An interesting implication of the second and third experiments is that what has been called emotional contagion with music, may correspond to a type of empathic response. Although the results did not clearly support this hypothesis, the possibility that emotional responses to music are mediated by empathy has been recently documented (Miu & Balteş, 2012; Vuoskoski et al., 2012). Future research should investigate to what extent, as I argued, these empathic responses to music can be explained by the same mechanisms as any other musical emotions, or they depend on other specific mechanisms. Furthermore, since several theories of social cognition have argued that processes such as mentalizing and emotional contagion depend on internal motor mechanisms (Iacoboni, 2009; Preston & de Waal, 2002), it would be interesting to establish if musically-induced empathy (and not only feelings of community, e.g. Hove & Risen, 2009) is modulated by embodied mechanisms such as rhythmic entrainment. This research should also explore the extent to which more cognitively-sophisticated mechanisms such as appraisals, or the construction of narratives have more weight in the induction of empathy than bodily mechanisms such as entrainment and motor simulation.

5. *The role of attention modality and listening perspective.* My constructionist theory predicts that the mode of attention that the listener devotes to the musical event is associated with different types of affective responses, which range from diffuse and world-focused affective responses, to discrete, self-focused emotions. Additionally, the results of the second experiment (reported in chapter seven) suggest that adopting a first or third person perspective when listening to "frightening" music can make the difference between undergoing feelings of power or of fear. Future research should explore the role that attention modality plays in musical emotions by manipulating the listeners' attitude (from detached to engaged), and observing the extent to which these variations in attention are associated with different types of affective responses. For example: does adopting a detached attention increase the probability that the listener experiences emotions as expressed by the music, rather than as induced ones?

   Future investigations should also establish which factors in the music, the situation, and the person's psychological state facilitate adopting a first or third person perspective on the music, and its affective consequences. For example, does the presence of a clear, *cantabile* melody facilitate adopting a first person perspective? Second, if adopting different listening perspectives modulates the phenomenon of "contagion" with frightening music, does this happen with other types of music, too? For example, does adopting a first person perspective while listening to sad music facilitate the induction of negative feelings of grief, whereas adopting a third person perspective facilitates experiencing positive feelings of calm and admiration of the music's beauty? Answering these questions has broader implications beyond academic music psychology. For instance, it can advance our understanding of how the music that people chose to listen to regulate their moods has positive or detrimental effects on their affective state.

6. *Methodological implications.* One of the main proposals of my theory is that several mechanisms usually produce only barely noticeable changes in core affect, and that they interact with conceptual mechanisms producing emotional and non-emotional responses. This implies self-report methods are not well-suited for studying this type of response. Future research should continue searching for alternative ways of

obtaining objective estimates of affective changes in listeners. Additionally, future studies should continue exploring ways of manipulating the interaction between these two types of mechanisms using different manipulations to the one implemented here (i.e. programme notes), such as the use of videos and lyrics.

9.4.1 Concluding remarks

Proposing a new theoretical perspective to account for the induction of emotions by music is undoubtedly a very ambitious enterprise. Therefore, although the constructionist theory I have presented intended to be as exhaustive and comprehensive as possible, the data from the empirical studies also showed it is necessary to continue refining the theoretical details of the theory, and the empirical hypotheses derived from it. Moreover, the evidence I presented for some of my claims is constrained by the limitations in the representativeness of the stimuli, the number of participants, and the shortcomings of the methods I implemented.

Some of the shortcomings of my theory are in fact, common to every theory of emotion elicitation. For instance, although almost all theories contain theoretical details about how different processes lead to the induction of full-blown emotions, many of these theoretical details still await empirical confirmation, and the question of how to operationalise this boundary between diffuse affect and emotion, and how to model the complexity of the factors involved is still work in progress (Meuleman & Scherer, 2013; Raz *et al.*, 2016).

Conversely, other limitations of my proposal have to do with the multidimensional nature of music itself. In comparison to the traditional visual stimuli used in affective science, music evolves and changes in time, and even when we try to study it as a simple acoustic stimulus, we find that it is actually composed of several physical dimensions, that people experience it as loaded with symbolic and affective meanings, and that it has multiple effects at somatic, cognitive, and affective levels. All of these characteristics make the challenge of disentangling core-affect processes and conceptual ones a huge task.

Despite these limitations, I consider that the constructionist theory I proposed offers useful insights about how musical emotions are created. This theory has not only provided specific hypotheses and avenues for future empirical research, but it also makes potentially useful suggestions to understand how musical meanings are constructed in wider musical contexts such as musical videos, film music, the use of music in advertisement, and the way patients and therapists create emotional meanings in music therapy. In this sense, this theory is well suited for starting building much needed bridges between music psychology and other disciplines interested in understanding people’s affective experiences with music such as ethnomusicology, historical musicology, popular music studies, sociology of music, and music therapy.

References

Ali, S. O., & Peynircioglu, Z. F. (2006). Songs and emotions: Are lyrics and melodies equal partners? *Psychology of Music*, *34*(4), 511–534. http://doi.org/10.1177/0305735606067168

Alpert, P. T., Miller, S. K., Wallmann, H., Havey, R., Cross, C., Chevalia, T., … Kodandapari, K. (2009). The effect of modified jazz dance on balance, cognition, and mood in older adults. *Journal of the American Academy of Nurse Practitioners*, *21*(2), 108–115. http://doi.org/10.1111/j.1745-7599.2008.00392.x

Anderson, C. A., Carnagey, N. L., & Eubanks, J. (2003). Exposure to violent media: The effects of songs with violent lyrics on aggressive thoughts and feelings. *Journal of Personality and Social Psychology*, *84*(5), 960–971. http://doi.org/10.1037/0022-3514.84.5.960

Arnold, M. (1960). *Emotion and personality*. New York: Columbia University Press.

Averill, J. R. (1980). A constructivist view of emotion. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research and experience: Vol. I. Theories of emotion* (pp. 305–339). New York: Academic Press, Inc.

Bachorowski, J.-A. (1999). Vocal expression and perception of emotion. *Current Directions in Psychological Science*, *8*(2), 53–57. http://doi.org/10.1111/1467-8721.00013

Balkwill, L.-L., & Thompson, W. F. (1999). A cross-cultural investigation of the perception of emotion in music: Psychophysical and cultural cues. *Music Perception*, *17*(1), 43–64.

Bangert, M., Peschel, T., Schlaug, G., Rotte, M., Drescher, D., Hinrichs, H., … Altenmüller, E. (2006). Shared networks for auditory and motor processing in professional pianists: Evidence from fMRI conjunction. *NeuroImage*, *30*(3), 917–926. http://doi.org/10.1016/j.neuroimage.2005.10.044

Banse, R., & Scherer, K. R. (1996). Acoustic profiles in vocal emotion expression. *Journal of Personality and Social Psychology*, *70*(3), 614–36. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8851745

Bänziger, T., Patel, S., & Scherer, K. R. (2014). The role of perceived voice and speech characteristics in vocal emotion communication. *Journal of Nonverbal Behavior*, *38*(1), 31–52. http://doi.org/10.1007/s10919-013-0165-x

Barrett, F. S., Grimm, K. J., Robins, R. W., Wildschut, T., Sedikides, C., & Janata, P. (2010). Music-evoked nostalgia: Affect, memory, and personality. *Emotion*, *10*(3), 390–403. http://doi.org/10.1037/a0019006

Barrett, L. F. (2006a). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*(1), 28–58. http://doi.org/10.1111/j.1745-6916.2006.00003.x

Barrett, L. F. (2006b). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review*, *10*(1), 20–46. http://doi.org/10.1207/s15327957pspr1001_2

Barrett, L. F. (2009). Variety is the spice of life: A psychological construction approach to understanding variability in emotion. *Cognition and Emotion Emotion*, *23*(7), 1284–1306. http://doi.org/10.1080/02699930902985894

Barrett, L. F. (2011). Constructing emotion. *Psychological Topics*, *20*(3), 359–380.

Barrett, L. F. (2012). Emotions are real. *Emotion*, *12*(3), 413–29. http://doi.org/10.1037/a0027555

Barrett, L. F. (2013). Psychological construction: The Darwinian approach to the science of emotion. *Emotion Review*, *5*(4), 379–389. http://doi.org/10.1177/1754073913489753

Barrett, L. F. (2014). The Conceptual Act Theory: A précis. *Emotion Review*, *6*(4), 292–297. http://doi.org/10.1177/1754073914534479

Barrett, L. F., & Bar, M. (2009). See it with feeling: Affective predictions during object perception. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*, 1325–34. http://doi.org/10.1098/rstb.2008.0312

Barrett, L. F., Lindquist, K. A., & Gendron, M. (2007). Language as context for the perception of emotion. *Trends in Cognitive Sciences*, *11*(8), 327–32. http://doi.org/10.1016/j.tics.2007.06.003

Barrett, L. F., Mesquita, B., & Gendron, M. (2011). Context in emotion perception. *Current Directions in Psychological Science*, *20*(5), 286–290. http://doi.org/10.1177/0963721411422522

Barrett, L. F., Mesquita, B., Gendron, M., & Kensinger, E. A. (2010). Context is routinely encoded during emotion perception. *Psychological Science*, *21*(4), 595–9. http://doi.org/10.1177/0956797610363547

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology*, *58*, 373–403. http://doi.org/10.1146/annurev.psych.58.110405.085709

Barrett, L. F., Mesquita, B., & Smith, E. R. (2010). The context principle. In *The mind in context* (pp. 1–22). New York, NY: Guildford.

Barrett, L. F., Quigley, K. S., Bliss-Moreau, E., & Aronson, K. R. (2004). Interoceptive sensitivity and self-reports of emotional experience. *Journal of Personality and Social Psychology*, *87*(5), 684–97. http://doi.org/10.1037/0022-3514.87.5.684

Barsalou, L. W. (2003). Abstraction in perceptual symbol systems. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *358*(1435), 1177–87. http://doi.org/10.1098/rstb.2003.1319

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, *59*, 617–45. http://doi.org/10.1146/annurev.psych.59.103006.093639

Baumeister, R. F., Vohs, K. D., DeWall, C. N., & Zhang, L. (2007). How emotion shapes behavior: feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*, *11*(2), 167–203. http://doi.org/10.1177/1088868307301033

Baumgartner, T., Esslen, M., & Jäncke, L. (2006). From emotion perception to emotion experience: Emotions evoked by pictures and classical music. *International Journal of Psychophysiology*, *60*(1), 34–43. citeulike:JOUR. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0167876005001327

Baumgartner, T., Lutz, K., Schmidt, C. F., & Jäncke, L. (2006). The emotional power of music: How music enhances the feeling of affective pictures. *Brain Research*, *1075*(1), 151–164. http://doi.org/10.1016/j.brainres.2005.12.065

Beck, J. (2015). Hard feelings: Science's struggle to define emotions. Retrieved February 17, 2016, from http://www.theatlantic.com/health/archive/2015/02/hard-feelings-sciences-struggle-to-define-emotions/385711/

Becker, J. (2010). Exploring the habitus of listening: anthropological perspectives. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 127–158). Oxford: Oxford University Press.

Beilock, S. L., & Holt, L. E. (2007). Embodied preference judgments: Can likeability be driven by the motor system? *Psychological Science*, *18*(1), 51–57. http://doi.org/10.1111/j.1467-9280.2007.01848.x

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Garden City, NY: Anchor Books.

Berlyne, D. E. (1971). *Aesthetics and Psychobiology*. New York: Appleton-Century Crofts.

Bharucha, J. J., Curtis, M., & Paroo, K. (2006). Varieties of musical experience. *Cognition*, *100*(1), 131–72. http://doi.org/10.1016/j.cognition.2005.11.008

Blairy, S., Herrera, P., & Hess, U. (1999). Mimicry and the judgment of emotional facial expressions. *Journal of Nonverbal Behavior*, *23*(1), 5–41. http://doi.org/10.1023/A:1021370825283

Boer, D., Fischer, R., Strack, M., Bond, M. H., Lo, E., & Lam, J. (2011). How shared preferences in music create bonds between people: values as the missing link. *Personality & Social Psychology Bulletin*, *37*(9), 1159–1171. http://doi.org/10.1177/0146167211407521

Boiger, M., & Mesquita, B. (2012). The construction of emotion in interactions, relationships, and cultures. *Emotion Review*, *4*(3), 221–229. http://doi.org/10.1177/1754073912439765

Bolivar, V. J., Cohen, A. J., & Fentress, J. C. (1994). Semantic and formal congruency in music and motion pictures: Effects on the interpretation of visual action. *Psychomusicology: A Journal of Research in Music Cognition*, *13*(1–2), 28–59. http://doi.org/10.1037/h0094102

Boltz, M. G. (2001). Musical soundtracks as a schematic influence on the cognitive processing of filmed events. *Music Perception*, *18*(4), 427–454. http://doi.org/10.1525/gfc.2008.8.4.24.This

Boltz, M. G., Ebendorf, B., & Field, B. (2009). Audiovisual interactions: The impact of visual information on music perception and memory. *Music Perception*, *27*(1), 43–59. http://doi.org/10.1525/rep.2014.126.1.1.1

Bonini Baraldi, F. (2009). All the pain and the joy of the world in a single melody: A transylvanian case study on musical emotion. *Music Perception*, *26*(3), 257–261. http://doi.org/10.1525/mp.2009.26.3.257

Bormann-Kischkel, C., Hildebrand-Pascher, S., & Stegbauer, G. (1990). The development of emotional concepts: A replication with a German sample. *International Journal of Behavioral Development*, *13*(3), 355–372. http://doi.org/10.1177/016502549001300308

Bossuyt, E., Moors, A., & De Houwer, J. (2014). Exploring the relations between regret, self-agency, and the tendency to repair using experimental methods and structural equation modeling. *The Psychological Record*, *64*(4), 841–857. http://doi.org/10.1007/s40732-014-0065-4

Bourgeois, P., & Hess, U. (2008). The impact of social context on mimicry. *Biological Psychology*, *77*(3), 343–352. http://doi.org/10.1016/j.biopsycho.2007.11.008

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*(2), 129–48.

Bowling, D. L., Sundararajan, J., Han, S., & Purves, D. (2012). Expression of emotion in Eastern and Western music mirrors vocalization. *PloS One*, *7*(3), e31942. http://doi.org/10.1371/journal.pone.0031942

Brosch, T. (2013). Comment: On the role of appraisal processes in the construction of emotion. *Emotion Review*, *5*(4), 369–373. http://doi.org/10.1177/1754073913489752

Brown, S., & Martinez, M. J. (2007). Activation of premotor vocal areas during musical discrimination. *Brain and Cognition*, *63*(1), 59–69. http://doi.org/10.1016/j.bandc.2006.08.006

Bruce, V., Doyle, T., Dench, N., Burton, M., Doyly, T., Dench, N., & Burton, M. (1991). Remembering facial configurations. *Cognition*, *38*(2), 109–144. http://doi.org/10.1016/0010-0277(91)90049-A

Buhmann, J., Desmet, F., Moens, B., Van Dyck, E., & Leman, M. (2016). Spontaneous velocity effect of musical expression on self-paced walking. *Plos One*, *11*(5), e0154414. http://doi.org/10.1371/journal.pone.0154414

Cabeza, R., Bruce, V., Kato, T., & Oda, M. (1999). The prototype effect in face recognition: Extension and limits. *Memory & Cognition*, *27*(1), 139–151. http://doi.org/10.3758/BF03201220

Cacioppo, J. T., Bertson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (Second, pp. 173–191). New York: The Guilford Press.

Callan, D. E., Tsytsarev, V., Hanakawa, T., Callan, A. M., Katsuhara, M., Fukuyama, H., & Turner, R. (2006). Song and speech: Brain regions involved with perception and covert production. *NeuroImage*, *31*(3), 1327–42. http://doi.org/10.1016/j.neuroimage.2006.01.036

Calvo-Merino, B., Glaser, D. E., Grèzes, J., Passingham, R. E., & Haggard, P. (2005). Action observation and acquired motor skills: An FMRI study with expert dancers. *Cerebral Cortex*, *15*(8), 1243–9. http://doi.org/10.1093/cercor/bhi007

Camras, L. A., Meng, Z., Ujiie, T., Dharamsi, S., Miyake, K., Oster, H., … Campos, J. (2002). Observing emotion in infants: Facial expression, body behavior, and rater judgments of responses to an expectancy-violating event. *Emotion*, *2*(2), 179–193. http://doi.org/10.1037/1528-3542.2.2.179

Carr, E. W., & Winkielman, P. (2014). When mirroring is both simple and “smart”: How mimicry can be embodied, adaptive, and non-representational. *Frontiers in Human Neuroscience*, *8*(July), 505. http://doi.org/10.3389/fnhum.2014.00505

Carroll, J. M., & Russell, J. A. (1996). Do facial expressions signal specific emotions? Judging emotion from the face in context. *Journal of Personality and Social Psychology*, *70*(2), 205–18. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8636880

Carroll, J. M., & Russell, J. A. (1997). Facial expressions in Hollywood’ s portrayal of emotion, *72*(1), 164–176.

Carver, C. S., & Scheier, M. F. (1990). Origins and functions of positive and negative affect: A control-process view. *Psychological Review*, *97*(1), 19–35. http://doi.org/10.1037/0033-295X.97.1.19

Chan, L. P., Livingstone, S. R., & Russo, F. A. (2013). Facial mimicry in response to song. *Music Perception*, *30*(4), 361–367.

Chen, J. L., Penhune, V. B., & Zatorre, R. J. (2008). Listening to musical rhythms recruits motor regions of the brain. *Cerebral Cortex*, *18*(12), 2844–2854. http://doi.org/10.1093/cercor/bhn042

Clarke, E. F. (1999). Subject-position and the specification of invariants in music by Frank Zappa and P.J. Harvey. *Music Analysis*, *18*(3), 347–374.

Clarke, E. F. (2005). *Ways of listening: An ecological approach to the perception of musical meaning*. Oxford: Oxford University Press.

Clarke, E. F. (2014). Lost and found in music: Music, consciousness and subjectivity. *Musicae Scientiae*, *18*(3), 354–368. http://doi.org/10.1177/1029864914533812

Clarke, E. F., DeNora, T., & Vuoskoski, J. (2015). Music, empathy and cultural understanding. *Physics of Life Reviews*, *15*, 61–88. http://doi.org/10.1016/j.plrev.2015.09.001

Clore, G. L., & Ortony, A. (2000). Cognition in emotion: Always, sometimes or never? In L. Nadel, R. Lane, & G. L. Ahern (Eds.), *Cognitive neuroscience of emotion* (pp. 24–61). Oxford: Oxford University Press.

Clore, G. L., & Ortony, A. (2008). Appraisal theories: How cognition shapes affect into emotion. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (pp. 628–642). New York: Guilford Press.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review*, *5*(4), 335–343. http://doi.org/10.1177/1754073913489751

Clore, G. L., & Schnall, S. (2008). Affective coherence: Affect as embodied evidence in attitude, advertising, and art. In G. R. Semin & E. Smith (Eds.), *Embodied grounding: Social, cognitive, affective, and neuroscientific approaches* (pp. 211–236). New York: Cambridge University Press.

Cochrane, T. (2010a). A simulation theory of musical expressivity. *Australasian Journal of Philosophy*, *88*(2), 191–207. http://doi.org/10.1080/00048400902941257

Cochrane, T. (2010b). Using the persona to express complex emotions in music. *Music Analysis*, *29*(1–3), 264–275. http://doi.org/10.1111/j.1468-2249.2011.00321.x

Cohen, A. J. (2001). Music as a source of emotion in film. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 249–272). Oxford.

Colling, L. J., & Thompson, W. F. (2013). Music, action, and affect. In T. Cochrane, B. Fantini, & K. R. Scherer (Eds.), *The emotional power of music, multidisciplinary perspectives on musical arousal, expression, and social control* (pp. 197–212). Oxford: Oxford University Press.

Cook, N. (1998). *Analysing Musical Multimedia*. New York: Oxford University Press.

Cook, N. (2001). Theorizing musical meaning. *Music Theory Spectrum*, *23*(2), 170–195. http://doi.org/10.1525/mts.2001.23.2.170

Coplan, A. (2011). Understanding empathy: Its features and effects. In A. Coplan & P. Goldie (Eds.), *Empathy: Philosophical and Psychological Perspectives* (pp. 3–18). Oxford: Oxford University Press. http://doi.org/10.1093/acprof

Costa, M., Fine, P., & Ricc Bitti, P. E. (2004). Interval distributions, mode, and tonal strength of melodies as predictors of perceived emotion. *Music Perception*, *22*(1), 1–14. http://doi.org/10.1525/rep.2008.104.1.92.This

Coutinho, E., & Cangelosi, A. (2011). Musical emotions: Predicting second-by-second subjective feelings of emotion from low-level psychoacoustic features and physiological measurements. *Emotion*, *11*(4), 921–37. http://doi.org/10.1037/a0024700

Coutinho, E., & Dibben, N. (2012). Psychoacoustic cues to emotion in speech prosody and music. *Cognition & Emotion*, *27*(April 2013), 37–41. http://doi.org/10.1080/02699931.2012.732559

Coutinho, E., & Scherer, K. R. (2015). Geneva music-induced affect checklist (GEMIAC). In *4th International Conference on Music and Emotion ICME IV* (p. 136).

Cox, A. (2011). Embodying music: Principles of the mimetic hypothesis. *Music Theory Online*, *17*(2), 1–24.

Cross, I. (2009). The evolutionary nature of musical meaning. *Musicae Scientiae*, *13*(2 Suppl), 179–200. http://doi.org/10.1177/1029864909013002091

Cunningham, W. A. (2013). Introduction to special section: Psychological constructivism. *Emotion Review*, *5*(4), 333–334. http://doi.org/10.1177/1754073913489786

Cunningham, W. A., Dunfield, K. a., & Stillman, P. E. (2013). Emotional states from affective dynamics. *Emotion Review*, *5*(4), 344–355. http://doi.org/10.1177/1754073913489749

Cunningham, W. A., & Zelazo, P. D. (2007). Attitudes and evaluations: A social cognitive neuroscience perspective. *Trends in Cognitive Sciences*, *11*(3), 97–104. http://doi.org/10.1016/j.tics.2006.12.005

Cunningham, W. A., Zelazo, P. D., Packer, D. J., & Van Bavel, J. J. (2007). The iterative reprocessing model: A multilevel framework for attitudes and evaluation. *Social Cognition*, *25*(5), 736–760. http://doi.org/10.1521/soco.2007.25.5.736

Curtis, M. E., & Bharucha, J. J. (2010). The minor third communicates sadness in speech, mirroring its use in music. *Emotion*, *10*(3), 335–48. http://doi.org/10.1037/a0017928

Dalla Bella, S., Peretz, I., Rousseau, L., & Gosselin, N. (2001). A developmental study of the affective value of tempo and mode in music. *Cognition*, *80*(3), 1–10. http://doi.org/10.1016/S0010-0277(00)00136-0

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Putnam.

Darwin, C. (1872). *The expression of emotion in man and animals*. New York: Appleton.

Davies, S. (1994). *Musical meaning and expression*. Ithaca, NY: Cornell University Press.

Davies, S. (2003). *Themes in the philosophy of music*. Oxford: Oxford University Press. http://doi.org/10.1093/mind/113.452.747

Davies, S. (2010). Emotions expressed and aroused by music: Philosophical perspectives. In N. Juslin, Patrik & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 15–43). Oxford: Oxford University Press.

Davies, S. (2013). Music to listener emotional contagion. In T. Cochrane, B. Fantini, & K. R. Scherer (Eds.), *The emotional power of music, multidisciplinary perspectives on musical arousal, expression, and social control* (pp. 169–176). Oxford: Oxford University Press.

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44*(1), 113–126. http://doi.org/10.1037/0022-3514.44.1.113

de Vignemont, F., & Singer, T. (2006). The empathic brain: How, when and why? *Trends in Cognitive Sciences*, *10*(10), 435–441. http://doi.org/10.1016/j.tics.2006.08.008

de Wied, M., Zillmann, D., & Ordman, V. (1995). The role of empathic distress in the enjoyment of cinematic tragedy. *Poetics*, *23*(1–2), 91–106. http://doi.org/10.1016/0304-422X(94)00010-4

Decety, J. (2010). To what extent is the experience of empathy mediated by shared neural circuits? *Emotion Review*, *2*(3), 204–207. http://doi.org/10.1177/1754073910361981

Dellacherie, D., Roy, M., Hugueville, L., Peretz, I., & Samson, S. (2011). The effect of musical experience on emotional self-reports and psychophysiological responses to dissonance. *Psychophysiology*, *48*(3), 337–49. http://doi.org/10.1111/j.1469-8986.2010.01075.x

Demos, A. P., Chaffin, R., Begosh, K. T., Daniels, J. R., & Marsh, K. L. (2012). Rocking to the beat: effects of music and partner's movements on spontaneous interpersonal coordination. *Journal of Experimental Psychology. General*, *141*(1), 49–53.

http://doi.org/10.1037/a0023843

DeNora, T. (2000). *Music in everyday life*. Cambridge: Cambridge University Press. http://doi.org/10.1017/CBO9781107415324.004

Deonna, J. A., & Scherer, K. R. (2009). The case of the disappearing intentional object: Constraints on a definition of emotion. *Emotion Review*, *2*(1), 44–52. http://doi.org/10.1177/1754073909345544

Deva, B. C., & Virmani, K. G. (1975). *A study in the psychological response to ragas. Research Report II of Sangeet Natak Akademi*. New Delhi, India: Indian Musicological Society.

Diaz, F. M. (2011). Mindfulness, attention, and flow during music listening: An empirical investigation. *Psychology of Music*, *41*(1), 42–58. http://doi.org/10.1177/0305735611415144

Dibben, N. (2001). What do we hear when we hear music? Music perception and music material. *Musicae Scientiae*, *5*(2), 161–194.

Dibben, N. (2004). The role of peripheral feedback in emotional experience with music. *Music Perception*, *22*(1), 79–115. http://doi.org/10.1017/CBO9781107415324.004

Dibben, N. (2006). Subjectivity and the construction of emotion in the music of Björk. *Music Analysis*, *25*(I–II), 171–197.

Dibben, N., & Williamson, V. J. (2007). An exploratory survey of in-vehicle music listening. *Psychology of Music*, *35*(4), 571–589. http://doi.org/10.1177/0305735607079725

Duncan, S., & Barrett, L. F. (2007). The role of the amygdala in visual awareness. *Trends in Cognitive Sciences*, *11*(5), 190–192.

Edelman, G. (2001). Consciousness: The remembered present. *Annals of the New York Academy of Sciences*, *929*(1), 111–122.

Eerola, T. (2011). Are the emotions expressed in music genre-specific? An audio-based evaluation of datasets spanning classical, film, pop and mixed genres. *Journal of New Music Research*, *40*(4), 349–366. http://doi.org/10.1080/09298215.2011.602195

Eerola, T., Friberg, A., & Bresin, R. (2013). Emotional expression in music: Contribution, linearity, and additivity of primary musical cues. *Frontiers in Psychology*, *4*(July), 487. http://doi.org/10.3389/fpsyg.2013.00487

Eerola, T., Peltola, H.-R., & Vuoskoski, J. K. (2015). Attitudes toward sad music are related to both preferential and contextual strategies. *Psychomusicology: Music, Mind, and Brain*, *25*(2), 116–123. http://doi.org/10.1037/pmu0000096

Eerola, T., & Vuoskoski, J. K. (2011). A comparison of the discrete and dimensional models of emotion in music. *Psychology of Music*, *39*(1), 18–49. http://doi.org/10.1177/0305735610362821

Eerola, T., & Vuoskoski, J. K. (2013). A review of music and emotion studies: Approaches, emotion models, and stimuli. *Music Perception*, *30*(3), 307–340.

Egermann, H., & McAdams, S. (2013). Empathy and emotional contagion as a link between recognized and felt emotions in music listening. *Music Perception*, *31*(2), 139–156. http://doi.org/10.1525/gfc.2008.8.4.24.This

Egermann, H., Nagel, F., Altenmüller, E., & Kopiez, R. (2009). Continuous measurement of musically-induced emotion: a web experiment. *International Journal of Internet Science*, *4*(1), 4–20.

Egermann, H., Pearce, M. T., Wiggins, G. A., & McAdams, S. (2013). Probabilistic models of expectation violation predict psychophysiological emotional responses to live concert music. *Cognitive, Affective & Behavioral Neuroscience*, *13*(3), 533–553. http://doi.org/10.3758/s13415-013-0161-y

Eitan, Z., & Granot, R. Y. (2006). How music moves: Musical parameters and listeners' images of motion. *Music Perception*, *23*(3), 221–247. http://doi.org/10.1038/149354c0

Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion*, *6*(3), 169–200. http://doi.org/10.1080/02699939208411068

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review*, *3*(4), 364–370. http://doi.org/10.1177/1754073911410740

Ekman, P., & Friesen, W. V. (1984). *Emotion facial action coding system (EM-FACS)*. San Francisco, CA: University of California Press.

Ekman, P., & Friesen, W. V. (1978). *Facial action coding system: A technique for the measurement of facial movement*. Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, *221*(4616), 1208–1210.

Elfenbein, H. A., & Ambady, N. (2003). Universals and cultural differences in recognizing emotions. *Current Directions in Psychological Science*, *12*(2), 159–165.

Elfenbein, H. A., Beaupré, M. G., Lévesque, M., & Hess, U. (2007). Toward a dialect theory: Cultural differences in the expression and recognition of posed facial expressions. *Emotion*, *7*(1), 131–146. http://doi.org/10.1037/1528-3542.7.1.131

Eliade, M. (1964). *Shamanism: Archaic techniques of ecstasy*. Princeton, NJ: Princeton University Press.

Ellsworth, P. C., & Smith, C. A. (1988). Shades of Joy: Patterns of appraisal differentiating pleasant emotions. *Cognition and Emotion*, *2*(4), 301–331. http://doi.org/10.1080/02699938808412702

Escoffier, N., Zhong, J., Schirmer, A., & Qiu, A. (2012). Emotional expressions in voice and music: Same code, same effect? *Human Brain Mapping*, *0*. http://doi.org/10.1002/hbm.22029

Evans, P., & Schubert, E. (2008). Relationships between expressed and felt emotions in music. *Musicae Scientiae*, *12*(1), 75–99. http://doi.org/10.1177/102986490801200105

Farbood, M. M. (2012). A parametric, temporal model of musical tension. *Music Perception*, *29*(4), 387–428. http://doi.org/10.1525/rep.2008.104.1.92.This

Faucher, L. (2013). Comment: Constructionisms? *Emotion Review*, *5*(4), 374–378. http://doi.org/10.1177/1754073913489754

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development*, *8*(2), 181–195. http://doi.org/10.1016/S0163-6383(85)80005-9

Field, A. (2013). *Discovering Statistics using IBM SPSS statistics* (4th Editio). London: SAGE Publications.

Finch, H. (2005). Comparison of the performance of nonparametric and parametric MANOVA test statistics when assumptions are violated. *Methodology*, *1*(1), 27–38. http://doi.org/10.1027/1614-1881.1.1.27

Fischer, P., & Greitemeyer, T. (2006). Music and Aggression: The Impact of Sexual-Aggressive Song Lyrics on Aggression-Related Thoughts, Emotions, and Behavior Toward the Same and the Opposite Sex. *Personality and Social Psychology Bulletin*, *32*(9), 1165–1176. http://doi.org/10.1177/0146167206288670

Fitch, W. . T., & Rosenfeld, A. J. (2007). Perception and production of syncopated rhythms. *Music Perception*, *25*(1), 43–58. Retrieved from http://www.jstor.org/stable/10.1525/mp.2007.25.1.43

Flack, W. (2006). Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings. *Cognition & Emotion*, *20*(2), 177–195. http://doi.org/10.1080/02699930500359617

Flaig, N. K., & Large, E. W. (2014). Dynamic musical communication of core affect. *Frontiers in Psychology*, *5*(MAR), 1–12. http://doi.org/10.3389/fpsyg.2014.00072

Fontaine, J. R. J., Scherer, K. R., Roesch, E. B., & Ellsworth, P. C. (2007). The world of emotion is not two-dimensional. *Psychological Science*, *18*(12), 1050–1057. http://doi.org/10.1111/j.1467-9280.2007.02024.x

Frank, M. G., & Stennett, J. (2001). The forced-choice paradigm and the perception of facial expressions of emotion. *Journal of Personality and Social Psychology*, *80*(1), 75–85. http://doi.org/10.1037/0022-3514.80.1.75

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego: Academic Press.

Frijda, N. H. (1986). *The emotions*. Cambridge: Cambridge University Press.

Frijda, N. H. (2008). The psychologist's point of view. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (3rd Editio, pp. 59–74). New York: Guilford Press.

Frijda, N. H., Kuipers, P., & ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology*, *57*(2), 212–228. http://doi.org/10.1037/0022-3514.57.2.212

Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, R., … Koelsch, S. (2009). Universal recognition of three basic emotions in music. *Current Biology*, *19*(7), 573–576. http://doi.org/10.1016/j.cub.2009.02.058

Fugate, J. M. B., & Barrett, L. F. (2014). The role of language on the perception and experience of emotion. In T. M. Holtgraves (Ed.), *Oxford Handbook of Language and Social Psychology*. Oxford: Oxford University Press.

Gabrielsson, A. (2001). Emotions in strong experiences with music. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 431–449). Oxford: Oxford University Press.

Gabrielsson, A., & Lindström, S. (2003). Strong experiences related to music: A descriptive system. *Musicae Scientiae*, *7*(2), 157–217. http://doi.org/10.1177/102986490300700201

Gallese, V., & Sinigaglia, C. (2011). What is so special about embodied simulation? *Trends in Cognitive Sciences*, *15*(11), 512–519. http://doi.org/10.1016/j.tics.2011.09.003

Garrido, S., & Schubert, E. (2011). Individual Differences in the Enjoyment of Negative Emotion in Music: A Literature Review and Experiment. *Music Perception*, *28*(3).

Geen, T. R. (1992). Facial expressions in socially isolated nonhuman primates: Open and closed programs for expressive behavior. *Journal of Research in Personality*, *26*(3), 273–280. http://doi.org/10.1016/0092-6566(92)90044-5

Gendron, M., Lindquist, K. A., Barsalou, L., & Barrett, L. F. (2012). Emotion words shape emotion percepts. *Emotion*, *12*(2), 314–25. http://doi.org/10.1037/a0026007

Geringer, J. M., Cassidy, J. W., & Byo, J. L. (1996). Effects of music with video on responses of nonmusic majors: An exploratory study. *Journal of Research in Music Education*, *44*(3), 240. http://doi.org/10.2307/3345597

Geringer, J. M., Cassidy, J. W., & Byo, J. L. (1997). Nonmusic majors' affective responses videos to performance and music programmatic. *Journal of Research in Music Education*, *45*(2), 221–233.

Giordano, B. L., Egermann, H., & Bresin, R. (2014). The production and perception of emotionally expressive walking sounds: Similarities between musical performance and everyday motor activity. *PLoS ONE*, *9*(12), 1–23. http://doi.org/10.1371/journal.pone.0115587

Glenberg, A. M. (2010). Embodiment as a unifying perspective for psychology. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(4), 586–596. http://doi.org/10.1002/wcs.55

Goldstone, R. L., Steyvers, M., & Rogosky, B. J. (2003). Conceptual interrelatedness and caricatures. *Memory & Cognition*, *31*(2), 169–180. http://doi.org/10.3758/BF03194377

Gosselin, P., Kirouac, G., & Doré, F. Y. (1995). Components and recognition of facial expression in the communication of emotion by actors. *Journal of Personality and Social Psychology*, *68*(1), 83–96. http://doi.org/10.1093/acprof:oso/9780195179644.003.0012

Grahn, J. A., & Brett, M. (2007). Rhythm and beat perception in motor areas of the brain. *Journal of Cognitive Neuroscience*, *19*(5), 893–906. http://doi.org/10.1162/jocn.2007.19.5.893

Granot, R. Y., & Eitan, Z. (2011). Musical tension and the interaction of dynamic auditory patterns. *Music Perception*, *28*(3), 219–246. http://doi.org/10.1525/rep.2014.126.1.1.1

Greasley, A. E., & Lamont, A. (2011). Exploring engagement with music in everyday life using experience sampling methodology. *Musicae Scientiae*, *15*(1), 45–71. http://doi.org/10.1177/1029864910393417

Gregory, A. H., Worrall, L., & Sarge, A. (1996). The development of emotional responses to music in young children. *Motivation and Emotion*, *20*(4), 341–348. http://doi.org/10.1007/BF02856522

Gross, J. J., & Barrett, L. F. (2011). Emotion generation and emotion regulation: One or two depends on your point of view. *Emotion Review*, *3*(1), 8–16. http://doi.org/10.1177/1754073910380974

Guéguen, N., Jacob, C., & Lamy, L. (2010). “Love is in the air”: Effects of songs with romantic lyrics on compliance with a courtship request. *Psychology of Music*, *38*(3), 303–307. http://doi.org/10.1177/0305735609360428

Gundlach, R. H. (1932). A quantitative analysis of Indian music. *American Journal of Psychology*, *44*, 133–145.

Gundlach, R. H. (1935). Factors determining the characterization of musical phrases. *American Journal of Psychology*, *47*, 624–643.

Gutsell, J. N., & Inzlicht, M. (2010). Empathy constrained: Prejudice predicts reduced mental simulation of actions during observation of outgroups. *Journal of Experimental Social Psychology*, *46*(5), 841–845. http://doi.org/10.1016/j.jesp.2010.03.011

Hariri, A. R., Bookheimer, S. Y., & Mazziotta, J. C. (2000). Modulating emotional responses: Effects of a neocortical network on the limbic system. *Neuroreport*, *11*(1), 43–48. http://doi.org/10.1097/00001756-200001170-00009

Harré, R. (1986). *The social construction of emotions*. (R. Harré, Ed.). Oxford: Blackwell Publishing.

Hatfield, E., Hsee, C. K., & Costello, J. (1995). The impact of vocal feedback on emotional experience and expression. *Journal of Social Behavior and Personality*, *10*, 293–313.

Hawk, S. T., Fischer, A. H., & Van Kleef, G. a. (2012). Face the noise: Embodied responses to nonverbal vocalizations of discrete emotions. *Journal of Personality and Social Psychology*, *102*(4), 796–814. http://doi.org/10.1037/a0026234

Hays, T., & Minichiello, V. (2005). The meaning of music in the lives of older people: a qualitative study. *Psychology of Music*, *33*(4), 437–451. http://doi.org/10.1177/0305735605056160

Hess, U., & Blairy, S. (2001). Facial mimicry and emotional contagion to dynamic emotional facial expressions and their influence on decoding accuracy. *International Journal of Psychophysiology : Official Journal of the International Organization of Psychophysiology*, *40*(2), 129–41. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11165351

Hess, U., & Fischer, A. (2013). Emotional mimicry as social regulation. *Personality and Social Psychology Review*, *17*(2), 142–157. http://doi.org/10.1177/1088868312472607

Hess, U., & Fischer, A. (2014). Emotional mimicry: why and when we mimic emotions. *Social and Personality Psychology Compass*, *8*(2), 45–57. http://doi.org/10.1111/spc3.12083

Hodges, D. A. (2010). Bodily responses to music. In S. Hallam, I. Cross, & M. Thaut (Eds.), *Oxford Handbook of Music Psychology* (pp. 121–130). Oxford: Oxford University Press.

Hommel, B., Musseler, J., Aschersleben, G., & Prinz, W. (2001). The theory of event-coding (TEC): A framework for perception and action planning. *Behavioural and Brain Sciences*, *24*, 849–937. http://doi.org/10.1017/S0140525X01000103

Hornby, N. (2003). *31 Songs*. New York: Riverhead Books.

Hove, M. J., & Risen, J. L. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition*, *27*(6), 949–960. http://doi.org/10.1521/soco.2009.27.6.949

Hui, E., Chui, B. T., & Woo, J. (2009). Effects of dance on physical and psychological well-being in older persons. *Archives of Gerontology and Geriatrics*, *49*(1), e45–e50. http://doi.org/10.1016/j.archger.2008.08.006

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2010). Feelings and perceptions of happiness and sadness induced by music: Similarities, differences, and mixed emotions. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(1), 47–56. http://doi.org/10.1037/a0016873

Huron, D. (2006). *Sweet anticipation: Music and the psychology of expectation*. Cambridge, MA.: MIT Press.

Huron, D., Kinney, D., & Precoda, K. (2006). Influence of pitch height on the perception of submissiveness and threat in musical passages. *Empirical Musicology Review*, *1*(3), 170–177.

Huron, D., & Ommen, A. (2006). An empirical study of syncopation in American popular music. *Music Theory Spectrum*, *28*(2), 211–231.

Hurtado de Mendoza, A., Fernández-Dols, J. M., Parrott, W. G., & Carrera, P. (2010). Emotion terms, category structure, and the problem of translation: The case of *shame* and *vergüenza*. *Cognition & Emotion*, *24*(4), 661–680. http://doi.org/10.1080/02699930902958255

Iacoboni, M. (2009). Imitation, empathy, and mirror neurons. *Annual Review of*

Psychology, *60*, 653–70. http://doi.org/10.1146/annurev.psych.60.110707.163604

Illie, G., & Thompson, W. F. (2006). A comparison of acoustic cues in music and speech for three dimensions of affect. *Music Perception*, *23*(4), 319–330. http://doi.org/10.1017/CBO9781107415324.004

Izard, C. E. (1977). *Humans Emotions*. New York: Plenum.

Izard, C. E. (1992). Basic emotions, relations among emotions, and emotion-cognition relations. *Psychological Review*, *99*(3), 561–565. http://doi.org/10.1037//0033-295X.99.3.561

Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology*, *60*, 1–25. http://doi.org/10.1146/annurev.psych.60.110707.163539

Izard, C. E., & Malatesta, C. E. (1987). Perspectives on emotional development: I. Differential emotions theory of early emotional development. In J. Osofsky (Ed.), *Handbook of infant development* (2nd Editio, pp. 494–54). New York: Wiley.

Jackendoff, R., & Lerdahl, F. (2006). The capacity for music: What is it, and what's special about it? *Cognition*, *100*(1), 33–72. http://doi.org/10.1016/j.cognition.2005.11.005

Jacob, P. (2008). What do mirror neurons contribute to human social cognition? *Mind & Language*, *23*(2), 190–223. http://doi.org/10.1111/j.1468-0017.2007.00337.x

Jacob, P., & Jeannerod, M. (2005). The motor theory of social cognition: A critique. *Trends in Cognitive Sciences*, *9*(1), 21–25. http://doi.org/10.1016/j.tics.2004.11.003

James, W. (1884). What is an Emotion? *Mind*, *9*(34), 188–205.

James, W. (1890). *The principles of psychology*. New York: Holt.

Janata, P., Tomic, S. T., & Haberman, J. M. (2012). Sensorimotor coupling in music and the psychology of the groove. *Journal of Experimental Psychology: General*, *141*(1), 54–75. http://doi.org/10.1037/a0024208

Janata, P., Tomic, S. T., & Rakowski, S. K. (2007). Characterisation of music-evoked autobiographical memories. *Memory*, *15*(8), 845–860. http://doi.org/10.1080/09658210701734593

Jeannerod, M. (1995). Mental imagery in the motor context. *Neurapsychologia*, *33*(11), 1419–1432.

Jeannerod, M., & Frak, V. (1999). Mental imaging of motor activity in humans. *Current Opinion in Neurobiology*, *9*(6), 735–739. http://doi.org/10.1016/S0959-4388(99)00038-0

Johnson, M. L., & Larson, S. (2003). "Something in the way she moves" - Metaphors of musical motion. *Metaphor and Symbol*, *18*(2), 63–84. http://doi.org/10.1207/S15327868MS1802_1

Juslin, P. N. (2003). Five facets of musical expression: A Psychologist's perspective on music performance. *Psychology of Music*, *31*(3), 273–302. http://doi.org/10.1177/03057356030313003

Juslin, P. N. (2013a). From everyday emotions to aesthetic emotions: Towards a unified theory of musical emotions. *Physics of Life Reviews*, *10*, 235–266. http://doi.org/10.1016/j.plrev.2013.05.008

Juslin, P. N. (2013b). From everyday emotions to aesthetic emotions: Towards a unified theory of musical emotions. *Physics of Life Reviews*, *10*(3), 235–266. http://doi.org/10.1016/j.plrev.2013.05.008

Juslin, P. N. (2013c). What does music express? Basic emotions and beyond. *Frontiers in Psychology*, *4*(SEP), 1–14. http://doi.org/10.3389/fpsyg.2013.00596

Juslin, P. N., Barradas, G. G., & Eerola, T. (2015). From sound to significance: Exploring the mechanisms underlying emotional reactions to music. *American Journal of Psychology*, *128*(3), 281–304. http://doi.org/10.5406/amerjpsyc.128.3.0281

Juslin, P. N., Harmat, L., & Eerola, T. (2013). What makes music emotionally significant? Exploring the underlying mechanisms. *Psychology of Music*, *42*(August), 599–623. http://doi.org/10.1177/0305735613484548

Juslin, P. N., & Isaksson, S. (2014). Subjective criteria for choice and aesthetic judgment of music: A comparison of psychology and music students. *Research Studies in Music Education*, *36*(2), 179–198. http://doi.org/10.1177/1321103X14540259

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin*, *129*(5), 770–814. http://doi.org/10.1037/0033-2909.129.5.770

Juslin, P. N., & Laukka, P. (2004). Expression, perception, and induction of musical emotions: A review and a questionnaire study of everyday listening. *Journal of New Music Research*, *33*(3), 217–238. http://doi.org/10.1080/0929821042000317813

Juslin, P. N., Liljeström, S., Laukka, P., Västfjäll, D., & Lundqvist, L.-O. (2011). Emotional reactions to music in a nationally representative sample of Swedish adults: Prevalence and causal influences. *Musicae Scientiae*, *15*(2), 174–207. http://doi.org/10.1177/1029864911401169

Juslin, P. N., Liljeström, S., & Västfjäll, D. (2010). How does music evoke emotions? Exploring the underlying mechanisms. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 605–642). Oxford: Oxford University Press.

Juslin, P. N., Liljeström, S., Västfjäll, D., Barradas, G., & Silva, A. (2008). An experience sampling study of emotional reactions to music: Listener, music, and situation. *Emotion*, *8*(5), 668–83. http://doi.org/10.1037/a0013505

Juslin, P. N., & Lindström, E. (2010). Musical expression of emotions: Modelling listeners' judgements of composed and performed features. *Music Analysis*, *29*(1–3), 334–364. http://doi.org/10.1111/j.1468-2249.2011.00323.x

Juslin, P. N., & Scherer, K. R. (2005). Vocal expression of affect. In J. A. Harrigan, R. Rosenthal, & K. R. Scherer (Eds.), *The New Handbook of Methods in Nonverbal Research* (pp. 65–135). Oxford: Oxford University Press.

Juslin, P. N., & Sloboda, J. A. (2001). *Music and emotion: Theory, and research*. (P. N. Juslin & J. A. Sloboda, Eds.). Oxford: Oxford University Press.

Juslin, P. N., & Sloboda, J. A. (2010a). *Handbook of music and emotion: Theory, research, applications*. (P. N. Juslin & J. A. Sloboda, Eds.). Oxford: Oxford University Press.

Juslin, P. N., & Sloboda, J. A. (2010b). Introduction: aims, organization, and terminology. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 3–14). Oxford: Oxford University Press.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *The Behavioral and Brain Sciences*, *31*(5), 559-575-621. http://doi.org/10.1017/S0140525X08006079

Kallinen, K., & Ravaja, N. (2006). Emotion perceived and emotion felt: Same and different. *Musicae Scientiae*, *10*(2), 191–213. http://doi.org/10.1177/102986490601000203

Karl, G., & Robinson, J. (1995). Shostakovich' s Tenth symphony and the musical expression of cognitively complex emotions. *The Journal of Aesthetics and Art Crticism*, *53*(4), 401–415. http://doi.org/10.2307/430975

Khalfa, S., Roy, M., Rainville, P., Dalla Bella, S., & Peretz, I. (2008). Role of tempo entrainment in psychophysiological differentiation of happy and sad music? *International Journal of Psychophysiology*, *68*(1), 17–26. http://doi.org/10.1016/j.ijpsycho.2007.12.001

Kirschner, S., & Tomasello, M. (2010). Joint music making promotes prosocial behavior in 4-year-old children. *Evolution and Human Behavior*, *31*(5), 354–364. http://doi.org/10.1016/j.evolhumbehav.2010.04.004

Kivy, P. (1999). Feeling the musical emotions. *British Journal of Aesthetics*, *39*, 1–13.

Kleinginna, P. R., & Kleinginna, A. M. (1981). A categorized list of motivation definitions, with a suggestion for a consensual definition. *Motivation and Emotion*, *5*(4), 345–379. http://doi.org/10.1007/BF00993889

Koch, S. C., Morlinghaus, K., & Fuchs, T. (2007). The joy dance. Specific effects of a single dance intervention on psychiatric patients with depression. *Arts in Psychotherapy*, *34*(4), 340–349. http://doi.org/10.1016/j.aip.2007.07.001

Koelsch, S., Fritz, T., Cramon, D. Y. V, Müller, K., Friederici, A. D., Cramon, V., … Friederici. (2006). Investigating emotion with music: an fMRI study. *Human Brain Mapping*, *27*(3), 239–50. http://doi.org/10.1002/hbm.20180

Koelsch, S., Fritz, T., Schulze, K., Alsop, D., & Schlaug, G. (2005). Adults and children processing music: An fMRI study. *NeuroImage*, *25*(4), 1068–1076. http://doi.org/10.1016/j.neuroimage.2004.12.050

Koelsch, S., Kasper, E., Sammler, D., Schulze, K., Gunter, T., & Friederici, A. D. (2004). Music, language and meaning: brain signatures of semantic processing. *Nature Neuroscience*, *7*(3), 302–7. http://doi.org/10.1038/nn1197

Koelsch, S., Kilches, S., Steinbeis, N., & Schelinski, S. (2008). Effects of unexpected chords and of performer's expression on brain responses and electrodermal activity. *PloS One*, *3*(7), e2631. http://doi.org/10.1371/journal.pone.0002631

Kragel, P. A., & LaBar, K. S. (2013). Multivariate pattern classification reveals autonomic and experiential representations of discrete emotions. *Emotion*, *13*(4), 681–690. http://doi.org/10.1037/a0031820

Krause, A. E., North, A. C., & Hewitt, L. Y. (2015). Music-listening in everyday life: Devices and choice. *Psychology of Music*, *43*(2), 155–170. http://doi.org/DOI: 10.1177/0305735613496860

Kraut, R. E., & Johnston, R. E. (1979). Social and emotional messages of smiling: An ethological approach. *Journal of Personality and Social Psychology*, *37*(9), 1539–1553. http://doi.org/10.1037//0022-3514.37.9.1539

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: a review. *Biological Psychology*, *84*(3), 394–421. Retrieved from http://dx.doi.org/10.1016/j.biopsycho.2010.03.010

Kristen, S., & Shevy, M. (2012). A comparison of German and American listeners' extra musical associations with popular music genres. *Psychology of Music*, *41*(6), 764–778. http://doi.org/10.1177/0305735612451785

Krumhansl, C. L., & Castellano, M. a. (1983). Dynamic processes in music perception. *Memory & Cognition*, *11*(4), 325–334. http://doi.org/10.3758/BF03202445

Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*. (U. of C. Press., Ed.). Chicago.

Kveraga, K., Ghuman, A. S., & Bar, M. (2007). Top-down predictions in the cognitive brain. *Brain and Cognition*, *65*(2), 145–168. http://doi.org/10.1016/j.bandc.2007.06.007

LaBar, K. S., Gitelman, D. R., Parrish, T. B., Kim, Y. H., Nobre, A. C., & Mesulam, M. M.

(2001). Hunger selectively modulates corticolimbic activation to food stimuli in humans. *Behavioral Neuroscience*, *115*(2), 493–500. http://doi.org/10.1037/0735-7044.115.2.493

Labbé, C., & Grandjean, D. (2014). Musical emotions predicted by feelings of entrainment. *Music Perception*, *32*(2), 170–185. http://doi.org/10.1525/MP.2014.32.2.170

Lambie, J. A., & Marcel, A. J. (2002). Consciousness and the varieties of emotion experience: A theoretical framework. *Psychological Review*, *109*(2), 219–259. http://doi.org/10.1037//0033-295X.109.2.219

Lamont, A. M. (2011). University students' strong experiences of music: Pleasure, engagement, and meaning. *Musicae Scientiae*, *15*(2), 229–249. http://doi.org/10.1177/1029864911403368

Large, E. W. (2008). Resonating to musical rhythm: theory and experiment. In *Psychology of time* (pp. 189–231). http://doi.org/10.1016/B978-0-08046-977-5.00006-5

Large, E. W., & Almonte, F. V. (2012). Neurodynamics, tonality, and the auditory brainstem response. *Annals of the New York Academy of Sciences*, *1252*(1), 10–13. http://doi.org/10.1111/j.1749-6632.2012.06594.x

Large, E. W., & Jones, M. R. (1999). The dynamics of attending: How people track time-varying events. *Psychological Review*, *106*(1), 119–159.

Large, E. W., & Kolen, J. F. (1994). Resonance and the perception of musical meter. *Connection Science*, *6*(2–3), 177–208. http://doi.org/10.1080/09540099408915723

Laukka, P. (2005). Categorical perception of vocal emotion expressions. *Emotion*, *5*(3), 277–295. http://doi.org/10.1037/1528-3542.5.3.277

Laukka, P., Eerola, T., Thingujam, N. S., Yamasaki, T., & Beller, G. (2013). Universal and culture-specific factors in the recognition and performance of musical affect expressions. *Emotion*, *13*(3), 434–49. http://doi.org/10.1037/a0031388

Launay, J. (2015). Musical sounds, motor resonance and agency detection. *Empirical Musicology Review*, *10*(1), 30–40.

Launay, J., Dean, R. T., & Bailes, F. (2013). Synchronization can influence trust following virtual interaction. *Experimental Psychology*, *60*(1), 53–63. http://doi.org/10.1027/1618-3169/a000173

Lazarus, R. S. (1966). *Psychological stress and the coping process*. New York: McGraw-Hill.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Lebrecht, S., Bar, M., Barrett, L. F., & Tarr, M. J. (2012). Micro-valences: Perceiving affective valence in everyday objects. *Frontiers in Psychology*, *3*(April), 107. http://doi.org/10.3389/fpsyg.2012.00107

Leman, M., Desmet, F., Styns, F., Van Noorden, L., Moelants, D., Noorden, L. Van, & Moelants, D. (2009). Sharing musical expression through embodied listening: A case study based on Chinese Guqin music. *Music Perception*, *26*(3), 263–278. http://doi.org/10.1017/CBO9781107415324.004

Leman, M., & Maes, P.-J. (2014). The role of embodiment in the perception of music. *Empirical Musicology Review*, *9*(3–4), 236–246.

Leman, M., Moelants, D., Varewyck, M., Styns, F., van Noorden, L., & Martens, J.-P. P. (2013). Activating and relaxing music entrains the speed of beat synchronized walking. *PLoS ONE*, *8*(7), e67932. http://doi.org/10.1371/journal.pone.0067932

Lerud, K. D., Almonte, F. V., Kim, J. C., & Large, E. W. (2014). Mode-locking neurodynamics predict human auditory brainstem responses to musical intervals. *Hearing Research*, *308*(September 2013), 41–49. http://doi.org/10.1016/j.heares.2013.09.010

Lindquist, K. A. (2009). Language is powerful. *Emotion Review*, *1*(1), 16–18. http://doi.org/10.1177/1754073908097177

Lindquist, K. A. (2013). Emotions emerge from more basic psychological ingredients: A modern psychological constructionist model. *Emotion Review*, *5*(4), 356–368. http://doi.org/10.1177/1754073913489750

Lindquist, K. A., & Barrett, L. F. (2008). Constructing emotion, the experience of fear as a conceptual act. *Psychological Science*, *19*(9), 898–903. http://doi.org/10.1111/j.1467-9280.2008.02174.x

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion*, *6*(1), 125–38. http://doi.org/10.1037/1528-3542.6.1.125

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *The Behavioral and Brain Sciences*, *35*(3), 121–43. http://doi.org/10.1017/S0140525X11000446

Lindström, E., Juslin, P. N., Bresin, R., & Williamon, A. (2003). "Expressivity comes from within your soul": A questionnaire study of music students' perspectives on expressivity. *Research Studies in Music Education*, *20*(1), 23–47. http://doi.org/10.1177/1321103X030200010201

Livingstone, S. R., & Thompson, W. F. (2009). The emergence of music from the theory of mind. *Musicae Scientiae*, *13*(2 Suppl), 83–115. http://doi.org/10.1177/1029864909013002061

Livingstone, S. R., Thompson, W. F., & Russo, F. A. (2009). Facial expressions and emotional singing: a study of perception and production with motion capture and electromyography. *Music Perception*, *26*(5), 475–488.

Livingstone, S. R., Thompson, W. F., Wanderley, M. M., & Palmer, C. (2015). Common cues to emotion in the dynamic facial expressions of speech and song. *Quarterly Journal of Experimental Psychology (2006)*, *68*(5), 952–970. http://doi.org/10.1080/17470218.2014.971034

London, J. (2012). *Hearing in time*. New York: Oxford University Press.

Longuet-Higgins, H. C., & Lee, C. S. (1984). The rhythmic interpretation of monophonic music. *Music Perception*, *1*(4), 424–440.

Luck, G., Saarikallio, S., Burger, B., Thompson, M., & Toiviainen, P. (2014). Emotion-driven encoding of music preference and personality in dance. *Musicae Scientiae*, *18*(3), 307–323. http://doi.org/10.1177/1029864914537290

Luck, G., Toiviainen, P., Erkkila, J., Lartillot, O., Riikkila, K., Mäkelä, A., … Värri, J. (2007). Modelling the relationships between emotional responses to, and musical content of, music therapy improvisations. *Psychology of Music*, *36*(1), 25–45. http://doi.org/10.1177/0305735607079714

Lundqvist, L.-O. O., Carlsson, F., Hilmersson, P., & Juslin, P. N. (2009). Emotional responses to music: experience, expression, and physiology. *Psychology of Music*, *37*(1), 61–90. http://doi.org/10.1177/0305735607086048

MacDonald, R. A. R., Hargreaves, D. J., & Miell, D. (2002). *Musical Identities*. Oxford: Oxford University Press.

Madison, G. (2006). Experiencing groove by music: Consistency and phenomenology. *Music Perception*, *24*(2), 201–208. http://doi.org/10.1017/CBO9781107415324.004

Maes, P.-J., Dyck, E. Van, Lesaffre, M., Leman, M., Kroonenber, P. M., Van Dyck, E., … Kroonenberg, P. (2014). The coupling of action and perception in musical meaning formation. *Music Perception*, *4*(2), 695–701. http://doi.org/10.1525/rep.2008.104.1.92.This

Maes, P.-J., & Leman, M. (2013). The influence of body movements on children's perception of music with an ambiguous expressive character. *PLoS ONE*, *8*(1), e54682. http://doi.org/10.1371/journal.pone.0054682

Maes, P.-J., Leman, M., Palmer, C., & Wanderley, M. M. (2014). Action-based effects on music perception. *Frontiers in Psychology*, *4*(January), 1008. http://doi.org/10.3389/fpsyg.2013.01008

Malbon, B. (1998). Clubbing: Consumption, identity and the spatial practices of every-night life. In T. Skelton & Valentine G. (Eds.), *Cool Places: Geographies of Youth Cultures* (pp. 266–286). London: Routledge.

Malm, W. P. (2001). *Traditional Japanese music and musical instruments: The new edition*. New York: Kodansha International.

Margulis, E. H. (2010). When program notes don't help: Music descriptions and enjoyment. *Psychology of Music*, *38*(3), 285–302. http://doi.org/10.1177/0305735609351921

Margulis, E. H., Kisida, B., & Greene, J. P. (2015). A knowing ear: The effect of explicit information on children's experience of a musical performance. *Psychology of Music*, *43*(4), 596–605. http://doi.org/10.1177/0305735613510343

Margulis, E. H., & Simchy-Gross, R. (2016). Repetition enhances the musicality of randomly generated tone sequences. *Music Perception*, *33*(4), 509–514.

Marr, D. (1982). *Vision: A computational investigation into the human representation and processing of visual information*. (D. Marr, Ed.). New York: Freeman.

Matsumoto, D. (1989). Cultural influences on the perception of emotion. *Journal of Cross-Cultural Psychology*, *20*(1), 92–105. http://doi.org/0803973233

Matsumoto, D., Keltner, D., Shiota, M. N., O'Sullivan, M., & Frank Mark. (2008). Facial expressions of emotion. In M. Lewis, J. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (Third Edit, pp. 211–234). New York: Guilford Press.

Matsumoto, D., & Willingham, B. (2009). Spontaneous facial expressions of emotion of congenitally and noncongenitally blind individuals. *Journal of Personality and Social Psychology*, *96*(1), 1–10. http://doi.org/10.1037/a0014037

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion*, *23*(2), 209–237. http://doi.org/10.1080/02699930802204677

Mcintosh, D. N. (2006). Spontaneous facial mimicry, liking and emotional contagion. *Polish Psychological Bulletin*, *37*(1), 31–42.

McKinney, C. H., Antoni, M. H., Kumar, M., Tims, F. C., & McCabe, P. M. (1997). Effects of guided imagery and music (GIM) therapy on mood and cortisol in healthy adults. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *16*(4), 390–400. http://doi.org/10.1037/0278-6133.16.4.390

Meuleman, B., & Scherer, K. R. (2013). Nonlinear appraisal modeling: An application of machine learning to the study of emotion production. *IEEE Transactions on Affective Computing*, *4*(4), 398–411. http://doi.org/10.1109/T-AFFC.2013.25

Meyer, L. B. (1956). *Emotion and meaning in music*. Chicago: University of Chicago Press.

Michael, J., Sandberg, K., Skewes, J., Wolf, T., Blicher, J., Overgaard, M., & Frith, C. D. (2014). Continuous theta-burst stimulation demonstrates a causal role of premotor homunculus in action understanding. *Psychological Science*, *25*(4), 963–72. http://doi.org/10.1177/0956797613520608

Miu, A. C., & Balteş, F. R. (2012). Empathy manipulation impacts music-induced emotions: A psychophysiological study on opera. *PLoS ONE*, *7*(1). http://doi.org/10.1371/journal.pone.0030618

Miu, A. C., & Vuoskoski, J. (2016). The social side of music listening: Empathy and contagion in music-induced emotions. In C. Waddington & E. King (Eds.), *Music and Empathy*. Farnham: Ashgate.

Molnar-Szakacs, I., & Overy, K. (2006). Music and mirror neurons: From motion to "e"motion. *Social Cognitive and Affective Neuroscience*, *1*(3), 235–41. http://doi.org/10.1093/scan/nsl029

Moors, A. (2009). Theories of emotion causation: A review. *Cognition & Emotion*, *23*(4), 625–662. http://doi.org/10.1080/02699930802645739

Moors, A. (2013). On the causal role of appraisal in emotion. *Emotion Review*, *5*(2), 132–140. http://doi.org/10.1177/1754073912463601

Moors, A. (2014). Flavors of appraisal theories. *Emotion Review*, *6*(4), 303–307. http://doi.org/10.1177/1754073914534477

Morey, R. (1940). Upset in emotions. *Journal of Social Psychology*, *12*, 333–356.

Mori, K., & Iwanaga, M. (2014). Pleasure generated by sadness: Effect of sad lyrics on the emotions induced by happy music. *Psychology of Music*, *42*(5), 643–652. http://doi.org/10.1177/0305735613483667

Müllensiefen, D., Gingras, B., Stewart, L., & Ji, J. (2013). *Goldsmiths Musical Sophistication Index (Gold-MSI) v1.0: Technical report and documentation revision 0.3*. London: Goldsmiths, University of London.

Mulligan, K., & Scherer, K. R. (2012). Toward a working definition of emotion. *Emotion Review*, *4*(4), 345–357. http://doi.org/10.1177/1754073912445818

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology*, *64*(5), 723–739.

Neumann, R., & Strack, F. (2000). "Mood contagion": The automatic transfer of mood between persons. *Journal of Personality and Social Psychology*, *79*(2), 211–223. http://doi.org/10.1037/0022-3514.79.2.211

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S. S., & Ric, F. F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review*, *9*(3), 184–211. http://doi.org/10.1207/s15327957pspr0903_1

Niedenthal, P. M., Brauer, M., Halberstadt, J. B., & Innes-Ker, Å. H. (2001). When did her smile drop? Facial mimicry and the influences of emotional state on the detection of change in emotional expression. *Cognition & Emotion*, *15*(6), 853–864. http://doi.org/10.1080/02699930143000194

Niedenthal, P. M., Halberstadt, J. B., & Margolin, J. (2000). Emotional state and the detection of change in facial expression of emotion. *European Journal of Social Psychology*, *30*, 211–223.

Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The Simulation of Smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *The Behavioral and Brain Sciences*, *33*(6), 417-433-480. http://doi.org/10.1017/S0140525X10000865

Niedenthal, P. M., Winkielman, P., Mondillon, L., & Vermeulen, N. (2009). Embodiment of emotion concepts. *Journal of Personality and Social Psychology*, *96*(6), 1120–36. http://doi.org/10.1037/a0015574

Nielsen. (2016). 2015 Nielsen Music U.S. Report. Retrieved February 1, 2016, from http://www.nielsen.com/us/en/insights/reports/2016/2015-music-us-year-end-report.html

Nielsen, F. V. (1987). Musical "tension" and related concepts. In T. A. Sebeok & J. Umiker-Sebeok (Eds.), *The semiotic web '86: An international yearbook* (pp. 491–514). Berlin: Mouton de Gruyter.

North, A. C., & Hargreaves, D. J. (1998). The effect of music on atmosphere and purchase intentions in a cafeteria. *Journal of Applied Social Psychology*, *28*(24), 2254–2273. http://doi.org/10.1111/j.1559-1816.1998.tb01370.x

North, A. C., Hargreaves, D. J., & McKendrick, J. (1997). In-store music affects product choice. *Nature*, *390*(November), 132. http://doi.org/10.1038/36484

Novembre, G., Ticini, L. F., Schütz-Bosbach, S., & Keller, P. E. (2014). Motor simulation and the coordination of self and other in real-time joint action. *Social Cognitive and Affective Neuroscience*, *9*(8), 1062–1068. http://doi.org/10.1093/scan/nst086

Oatley, K., & Johnson-Laird, P. N. (1987). Towards a cognitive theory of emotions. *Cognition and Emotion*, *1*, 29–50.

Oosterwijk, S., Rotteveel, M., Fischer, A. H., & Hess, U. (2009). Embodied emotion concepts: How generating words about pride and disappointment influences posture. *European Journal of Social Psychology*, *39*, 457–466. http://doi.org/10.1002/ejsp

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions*. Cambridge: Cambridge University Press.

Ortony, A., Norman, D. A., & Revelle, W. (2005). Affect and proto-affect in effective functioning. In J. M. Fellous & M. A. Arbib (Eds.), *Who needs emotions: The brain meets the machine* (pp. 174–202). New York, NY: Oxford University Press. http://doi.org/10.1093/acprof:oso/9780195166194.003.0007

Ortony, A., & Turner, T. J. (1990). What' s basic about basic emotions? *Psychological Review*, *97*(3), 315–331. http://doi.org/10.1037/0033-295X.97.3.315

Osgood, C. E., May, W. H., & Miron, M. S. (1975). *Cross-cultural universals of affective meaning*. Chicago: University of Illinois Press.

Overy, K., & Molnar-Szakacs, I. (2009). Being together in time: Musical experience and the mirror neuron system. *Music Perception*, *26*(5), 489–504. http://doi.org/10.1017/CBO9781107415324.004

Painter, J. G., & Koelsch, S. (2011). Can out-of-context musical sounds convey meaning? An ERP study on the processing of meaning in music. *Psychophysiology*, *48*(5), 645–655. http://doi.org/10.1111/j.1469-8986.2010.01134.x

Panksepp, J. (1992). A critical role for "affective neuroscience" in resolving what is basic about emotions. *Psychological Review*, *99*(3), 554–560.

Panksepp, J. (2000). Emotions as natural kinds within the mammalian brain. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (2nd Editio, pp. 137–156). New York: Guilford Press.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives on Psychological Science*, *2*(3), 281–296.

Papinczak, Z. E., Dingle, G. A., Stoyanov, S. R., Hides, L., & Zelenko, O. (2015). Young people's uses of music for well-being. *Journal of Youth Studies*, *18*(February), 1–16.

http://doi.org/10.1080/13676261.2015.1020935

Parncutt, R. (1994). A perceptual model of pulse salience and metrical accent in musical rhythms. *Music Perception*, *11*(4), 409–464. http://doi.org/10.2307/40285633

Parncutt, R. (2014). The emotional connotations of major versus minor tonality: One or more origins? *Musicae Scientiae*, *18*(3), 324–353. http://doi.org/10.1177/1029864914542842

Parr, L. A., Waller, B. M., & Fugate, J. (2005). Emotional communication in primates: Implications for neurobiology. *Current Opinion in Neurobiology*, *15*(6), 716–720. http://doi.org/10.1016/j.conb.2005.10.017.Emotional

Pavlović, I., & Marković, S. (2011). The effect of music background on the emotional appraisal of film sequences. *Psihologija*, *44*(1), 71–91. http://doi.org/10.2298/PSI1101071P

Pearce, M. T., & Wiggins, G. A. (2006). Expectation in melody: The influence of context and learning. *Music Perception*, *23*(5), 377–405.

Pecher, D., van Dantzig, S., & Schifferstein, H. N. J. (2009). Concepts are not represented by conscious imagery. *Psychonomic Bulletin & Review*, *16*(5), 914–9. http://doi.org/10.3758/PBR.16.5.914

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology*, *19*, 1–24.

Phillips-Silver, J., & Trainor, L. J. (2008). Vestibular influence on auditory metrical interpretation. *Brain and Cognition*, *67*(1), 94–102. http://doi.org/10.1016/j.bandc.2007.11.007

Piaget, J. (1980). The constructivist approach: Recent studies in genetic epistemology. *Cahiers de La Fondation Archives Jean Piaget*, *1*(1), 1–7.

Plutchik, R. (1980). *Emotion: A psychoevolutionary synthesis*. New York: Harper & Row.

Popper, K. (1992). *The logic of scientific discovery*. London: Routledge.

Preston, S. D., & de Waal, F. B. M. (2002). Empathy: Its ultimate and proximate bases. *The Behavioral and Brain Sciences*, *25*(1), 1-20-71. http://doi.org/10.1017/S0140525X02000018

Prinz, J. J. (2004). *Gut reactions: A perceptual theory of emotion*. *British Journal of Aesthetics* (Vol. 46). http://doi.org/10.1093/mind/fzl450

Prinz, W. (1997). Perception and action planning. *The European Journal of Cognitive Psychology*, *9*(February 2014), 129–154. http://doi.org/10.1080/713752551

Quinto, L., Thompson, W. F., & Keating, F. L. (2013). Emotional communication in speech and music: The role of melodic and rhythmic contrasts. *Frontiers in Psychology*, *4*(APR), 1–8. http://doi.org/10.3389/fpsyg.2013.00184

Quinto, L., Thompson, W. F., & Taylor, A. (2014). The contributions of compositional structure and performance expression to the communication of emotion in music. *Psychology of Music*, *42*(4), 503–524. http://doi.org/10.1177/0305735613482023

Quiroga Murcia, C., Bongard, S., & Kreutz, G. (2009). Emotional and neurohumoral responses to dancing tango argentino: The effects of music and partner. *Music and Medicine*, *1*(1), 14–21. http://doi.org/10.1177/1943862109335064

Raz, G., Touroutoglou, A., Wilson-Mendenhall, C., Gilam, G., Lin, T., Gonen, T., … Barrett, L. F. (2016). Functional connectivity dynamics during film viewing reveal common networks for different emotional experiences. *Cognitive, Affective, & Behavioral Neuroscience*, (May). http://doi.org/10.3758/s13415-016-0425-4

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review*, *8*(4), 364–382. http://doi.org/10.1207/s15327957pspr0804_3

Rommers, J., Meyer, A. S., & Huettig, F. (2013). Object shape and orientation do not routinely influence performance during language processing. *Psychological Science*, *24*(11), 2218–25. http://doi.org/10.1177/0956797613490746

Roseman, I. J., Wiest, C., & Swartz, T. S. (1994). Phenomenology, behaviors, and goals differentiate discrete emotions. *Journal of Personality and Social Psychology*, *67*(2), 206–221. http://doi.org/10.1037/0022-3514.67.2.206

Rouget, G. (1985). *Music and trance: A theory of the relation between music and possession*. Chicago: University of Chicago Press.

Rozin, P., Berman, L., & Royzman, E. (2010). Biases in use of positive and negative words across twenty natural languages. *Cognition & Emotion*, *24*(3), 536–548. http://doi.org/10.1080/02699930902793462

Ruiz-Belda, M. A., Fernandez-Dols, J. M., Carrera, P., & Barchard, K. (2003). Spontaneous facial expressions of happy bowlers and soccer fans. *Cognition & Emotion*, *17*(2), 315–326. http://doi.org/Doi 10.1080/02699930244000327

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin*, *115*(1), 102–41. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8202574

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, *110*(1), 145–172. http://doi.org/10.1037/0033-295X.110.1.145

Russell, J. A. (2012). Introduction to special section: On defining emotion. *Emotion Review*, *4*(4), 337–337. http://doi.org/10.1177/1754073912445857

Russell, J. A., Bachorowski, J.-A., & Fernández-Dols, J. M. (2003). Facial and vocal expressions of emotion. *Annual Review of Psychology*, *54*, 329–349. http://doi.org/10.1146/annurev.psych.54.101601.145102

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*(5), 805–819. http://doi.org/10.1037/0022-3514.76.5.805

Russell, J. A., & Fehr, B. (1994). Fuzzy concepts in a fuzzy hierarchy: Varieties of anger. *Journal of Personality and Social Psychology*, *67*(2), 186–205.

Russo, F. A., Vempala, N. N., & Sandstrom, G. M. (2013). Predicting musically induced emotions from physiological inputs: Linear and neural network models. *Frontiers in Psychology*, *4*(AUG), 1–8. http://doi.org/10.3389/fpsyg.2013.00468

Saarikallio, S., & Erkkila, J. (2007). The role of music in adolescents' mood regulation. *Psychology of Music*, *35*(1), 88–109. http://doi.org/10.1177/0305735607068889

Saarikallio, S., Luck, G., Burger, B., Thompson, M., & Toiviainen, P. (2013). Dance moves reflect current affective state illustrative of approach–avoidance motivation. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 296–305. http://doi.org/10.1037/a0032589

Sander, D., Grandjean, D., & Scherer, K. R. (2005). A systems approach to appraisal mechanisms in emotion. *Neural Networks : The Official Journal of the International Neural Network Society*, *18*(4), 317–52. http://doi.org/10.1016/j.neunet.2005.03.001

Scarantino, A. (2012). How to define emotions scientifically. *Emotion Review*, *4*(4), 358–368. http://doi.org/10.1177/1754073912445810

Scarantino, A. (2015). The Component Process Model of emotion, and the power of coincidences (Interview with Klaus Scherer). Retrieved October 1, 2016, from http://emotionresearcher.com/the-component-process-model-of-emotion-and-the-power-of-coincidences/

Scarantino, A., & Griffiths, P. (2011). Don't give up on basic emotions. *Emotion Review*, *3*(4), 444–454. http://doi.org/10.1177/1754073911410745

Schachter, S., & Singer, J. E. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review*, *69*(5), 379–399. http://doi.org/10.1037/h0021465

Schäfer, T., & Sedlmeier, P. (2010). What makes us like music? Determinants of music preference. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(4), 223–234. http://doi.org/10.1037/a0018374

Schellenberg, E. G., Peretz, I., & Vieillard, S. (2008). Liking for happy- and sad-sounding music: Effects of exposure. *Cognition & Emotion*, *22*(2), 218–237. http://doi.org/10.1080/02699930701350753

Scherer, K. R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin*, *99*(2), 143–165. http://doi.org/10.1037/0033-2909.99.2.143

Scherer, K. R. (1994). Toward a concept of “modal emotions.” In P. Ekman & R. Davidson (Eds.), *The nature of emotion: Fundamental questions.* (pp. 25–31). Oxford: Oxford University Press.

Scherer, K. R. (2000). Psychological models of emotion. *The Neuropsychology of Emotion*. http://doi.org/10.1097/00001504-198811000-00012

Scherer, K. R. (2003). Vocal communication of emotion: A review of research paradigms. *Speech Communication*, *40*(1–2), 227–256. http://doi.org/10.1016/S0167-6393(02)00084-5

Scherer, K. R. (2004). Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research*, *33*(3), 239–251. http://doi.org/10.1080/0929821042000317822

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, *44*(4), 695–729. http://doi.org/10.1177/0539018405058216

Scherer, K. R. (2009a). Emotions are emergent processes: They require a dynamic computational architecture. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*, 3459–74. http://doi.org/10.1098/rstb.2009.0141

Scherer, K. R. (2009b). The dynamic architecture of emotion: Evidence for the component process model. *Cognition & Emotion*, *23*(7), 1307–1351. http://doi.org/10.1080/02699930902928969

Scherer, K. R. (2013). The nature and dynamics of relevance and valence appraisals: Theoretical advances and recent evidence. *Emotion Review*, *5*(2), 150–162. http://doi.org/10.1177/1754073912468166

Scherer, K. R., Clark-Polner, E., & Mortillaro, M. (2011). In the eye of the beholder? Universality and cultural specificity in the expression and perception of emotion. *International Journal of Psychology*, *46*(6), 401–435. http://doi.org/10.1080/00207594.2011.626049

Scherer, K. R., & Coutinho, E. (2013). How music creates emotion: A multifactorial process approach. In T. Cochrane, B. Fantini, & K. R. Scherer (Eds.), *The Emotional Power of Music, Multidisciplinary perspectives on musical arousal, expression, and social control* (pp. 121–145). Oxford: Oxford University Press.

Scherer, K. R., & Ellgring, H. (2007). Are facial expressions of emotion produced by categorical affect programs or dynamically driven by appraisal? *Emotion*, *7*(1), 113–30. http://doi.org/10.1037/1528-3542.7.1.113

Scherer, K. R., Johnstone, T., & Klasmeyer, G. (2003). Vocal expression of emotion. In R. J. Davidson, K. R. Scherer, & Goldsmith H. Hill (Eds.), *Handbook of affective sciences* (pp. 433–456). Oxford: Oxford University Press.

Scherer, K. R., Sundberg, J., Tamarit, L., & Salomão, G. L. (2013). Comparing the acoustic expression of emotion in the speaking and the singing voice. *Computer Speech & Language*, *29*(1), 218–235. http://doi.org/10.1016/j.csl.2013.10.002

Scherer, K. R., & Zentner, M. R. (2001). Emotional effects of music: Production rules. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 361–392). Oxford: Oxford University Press.

Scherer, K. R., Zentner, M. R., & Schacht, A. (2002). Emotional states generated by music: an exploratory study of music experts. *Musicae Scientiae*, *5*, 149–171. http://doi.org/10.1177/10298649020050S106

Schimmack, U., & Grob, A. (2000). Dimensional models of core affect: A quantitative comparison by means of structural equation modelling. *European Journal of Personality*, *14*(March 1999), 325–345. http://doi.org/10.1002/1099-0984(200007/08)14:4<325::AID-PER380>3.0.CO;2-I

Schimmack, U., & Rainer, R. (2002). Experiencing activation: Energetic arousal and tense arousal are not mixtures of valence and activation. *Emotion*, *2*(4), 412–417. http://doi.org/10.1037//1528-3542.2.4.412

Scholer, F. (2016). ANOVA (and R). Retrieved January 1, 2016, from http://goanna.cs.rmit.edu.au/~fscholer/anova.php

Schooler, J., Mrazek, M., Baird, B., & Winkielman, P. (2015). Minding the mind: The value of distinguishing among unconscious, conscious, and metaconscious processes. *Minding the Mind: The Value of Distinguishing among Unconscious, Conscious, and Metaconscious Processes.*, *1*, 179–202. http://doi.org/10.1037/14341-005

Schubert, E. (2004). Modeling perceived emotion with continuous musical features. *Music Perception*, *21*(4), 561–585. http://doi.org/10.1525/mp.2004.21.4.561

Schubert, E. (2007). The influence of emotion, locus of emotion and familiarity upon preference in music. *Psychology of Music*, *35*(3), 499–515. http://doi.org/10.1177/0305735607072657

Schubert, E. (2009). The fundamental function of music. *Musicae Scientiae*, *13*(2 Suppl), 63–81. http://doi.org/10.1177/1029864909013002051

Schubert, E. (2013). Emotion felt by the listener and expressed by the music: Literature review and theoretical perspectives. *Frontiers in Psychology*, *4*(December), 1–18. http://doi.org/10.3389/fpsyg.2013.00837

Sedlmeier, P., Weigelt, O., & Walther, E. (2011). Music in the muscle: How embodied cognition may influence music preferences. *Music Perception*, *28*(3), 297–306.

Sievers, B., Polansky, L., Casey, M., & Wheatley, T. (2012). Music and movement share a dynamic structure that supports universal expressions of emotion. http://doi.org/10.1073/pnas.1209023110/-/DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1209023110

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature*, *439*(7075), 466–469. http://doi.org/10.1038/nature04271

Sloboda, J. A. (1991). Music structure and emotional response: Some empirical findings. *Psychology of Music*, *19*(2), 110–120. http://doi.org/10.1177/0305735691192002

Sloboda, J. A. (1998). Does music mean anything? *Musicae Scientiae*, *II*(1), 21–31.

Sloboda, J. A. (2010). Music in everyday life: The role of emotions. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 493–514). Oxford: Oxford University Press.

Sloboda, J. A., & O'Neill, S. A. (2001). Emotions in everyday listening to music. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research*. Oxford: Oxford University Press. http://doi.org/10.1017/CBO9781107415324.004

Sloboda, J. A., O'Neill, S. A., & Ivaldi, A. (2001). Functions of music in everyday life: an exploratory study using the experience sampling method. *Musicae Scientiae*, *5*(1), 9–32. http://doi.org/10.1177/102986490100500102

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality & Social Psychology*, *48*(4), 813–838. http://doi.org/10.1037/0022-3514.48.4.813

Solso, R. L., & McCarthy, J. E. (1981). Prototype formation of faces: A case of pseudo-memory. *British Journal of Psychology*, *72*(4), 499–503. http://doi.org/10.1111/j.2044-8295.1981.tb01779.x

Springer, A., Parkinson, J., & Prinz, W. (2013). Action simulation: Time course and representational mechanisms. *Frontiers in Psychology*, *4*, 1–20. http://doi.org/10.3389/fpsyg.2013.00387

Steinbeis, N., & Koelsch, S. (2008). Shared neural resources between music and language indicate semantic processing of musical tension-resolution patterns. *Cerebral Cortex*, *18*(5), 1169–78. http://doi.org/10.1093/cercor/bhm149

Steinbeis, N., Koelsch, S., & Sloboda, J. A. (2006). The role of harmonic expectancy violations in musical emotions: Evidence from subjective, physiological, and neural responses. *Journal of Cognitive Neuroscience*, *18*(8), 1380–1393. http://doi.org/10.1162/jocn.2006.18.8.1380

Stephens, C. L., Christie, I. C., & Friedman, B. H. (2010). Autonomic specificity of basic emotions: Evidence from pattern classification and cluster analysis. *Biological Psychology*, *84*(3), 463–473. http://doi.org/10.1016/j.biopsycho.2010.03.014

Stupacher, J., Hove, M. J., Novembre, G., Schütz-Bosbach, S., & Keller, P. E. (2013). Musical groove modulates motor cortex excitability: A TMS investigation. *Brain and Cognition*, *82*, 127–136.

Styns, F., van Noorden, L., Moelants, D., & Leman, M. (2007). Walking on music. *Human Movement Science*, *26*(5), 769–785. http://doi.org/10.1016/j.humov.2007.07.007

Tagg, P., & Clarida, B. (2003). *Ten little tunes: Towards a musicology of the mass Media*. Montreal: Mass Media Music Scholars' Press.

Tan, S., Spackman, M. P., Bezdek, M. A., & Paterson, G. (2007). Viewers' interpretations of film characters' emotions: Effects of presenting film music before or after a character is shown. *Music Perception*, *25*(2), 135–152. http://doi.org/10.1525/rep.2014.126.1.1.1

Tarr, B., Launay, J., Cohen, E., & Dunbar, R. (2015). Synchrony and exertion during dance independently raise pain threshold and encourage social bonding. *Biology Letters*, *11*(November), 0–3. http://doi.org/10.1098/rsbl.2015.0767

Tesoriero, M., & Rickard, N. S. (2012). Music-enhanced recall: An effect of mood congruence, emotion arousal or emotion function? *Musicae Scientiae*, *16*(3), 340–356. http://doi.org/10.1177/1029864912459046

Thayer, R. E. (1989). *The biopsychology of mood*. New York: Oxford University Press.

Thissen, D., Steinberg, L., & Kuang, D. (2002). Quick and easy implementation of the

Benjamini-Hochberg procedure for controlling the false positive rate in multiple comparisons. *Journal of Educational and Behavioral Statistics*, *27*(1), 77–83.

Thompson, W. F., & Balkwill, L.-L. (2010). Cross-cultural similarities and differences. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications*. Oxford: Oxford University Press.

Thompson, W. F., & Coltheart, M. (2008). The role of signal detection and amplification in the induction of emotion by music. *Behavioral and Brain Sciences*, *31*, 597–598. http://doi.org/doi:10.1017/S0140525X08005529

Thompson, W. F., Graham, P., & Russo, F. A. (2005). Seeing music performance: Visual influences on perception and experience. *Semiotica*, *156*, 203–227.

Thompson, W. F., & Russo, F. A. (2004). The attribution of meaning and emotion to song lyrics. *Polskie Forum Psychologiczne*, *9*, 51–62.

Thompson, W. F., Russo, F. A., & Quinto, L. (2008). Audio-visual integration of emotional cues in song. *Cognition & Emotion*, *22*(8), 1457–1470. http://doi.org/10.1080/02699930701813974

Thompson, W. F., Russo, F. A., & Sinclair, D. (1994). Effects of underscoring on the perception of closure in filmed events. *Psychomusicology: A Journal of Research in Music Cognition*, *13*, 9–27. http://doi.org/10.1037/h0094103

Tomkins, S. S. (1962). *Affect, imagery, and consciousness: Vol. 1. The positive affects.* New York: Springer.

Tomkins, S. S. (1963). *Affect, imagery, and consciousness: Vol. 2. The negative affects*. New York: Springer.

Trainor, L. J., & Heinmiller, B. M. (1998). The development of evaluative responses to music: Infants prefer to listen to consonance over dissonance. *Infant Behavior and Development*, *21*(1), 77–88. http://doi.org/10.1016/S0163-6383(98)90055-8

Trost, W., Ethofer, T., Zentner, M. R., & Vuilleumier, P. (2012). Mapping aesthetic musical emotions in the brain. *Cerebral Cortex*, *22*(12), 2769–2783. http://doi.org/10.1093/cercor/bhr353

Trost, W., & Vuilleumier, P. (2013). Rhythmic entrainment as a mechanism for emotion induction by music: A neurophysiological perspective. In T. Cochrane, B. Fantini, & K. R. Scherer (Eds.), *The emotional power of music, multidisciplinary perspectives on musical arousal, expression, and social control* (pp. 213–226). Oxford: Oxford University Press.

Van den Tol, A. J. M., & Edwards, J. (2011). Exploring a rationale for choosing to listen to sad music when feeling sad. *Psychology of Music*, *41*(4), 440–465. http://doi.org/10.1177/0305735611430433

Van den Tol, A. J. M., & Edwards, J. (2014). Listening to sad music in adverse situations: How music selection strategies relate to self-regulatory goals, listening effects, and mood enhancement. *Psychology of Music*, *Published*(4), 473–494. http://doi.org/10.1177/0305735613517410

Van der Schalk, J., Hawk, S. T., Fischer, A. H., & Doosje, B. J. (2011). Moving faces, looking places: The Amsterdam Dynamic Facial Expressions Set (ADFES). *Emotion*, *11*, 907–920. http://doi.org/10.1037/a0023853

van der Zwaag, M. D., Westerink, J. H. D. M., & van den Broek, E. L. (2011). Emotional and psychophysiological responses to tempo, mode, and percussiveness. *Musicae Scientiae*, *15*(2), 250–269. http://doi.org/10.1177/1029864911403364

Vieillard, S., Peretz, I., Gosselin, N., Khalfa, S., Gagnon, L., & Bouchard, B. (2008). Happy, sad, scary and peaceful musical excerpts for research on emotions. *Cognition &*

Emotion, *22*(4), 720–752. http://doi.org/10.1080/02699930701503567

Vuoskoski, J. K., & Eerola, T. (2013). Extramusical information contributes to emotions induced by music. *Psychology of Music*, *43*(September), 262–274. http://doi.org/10.1177/0305735613502373

Vuoskoski, J. K., Thompson, W. F., McIlwain, D., & Eerola, T. (2012). Who enjoys listening to sad music and why? *Music Perception*, *29*(3), 311–317.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Cambridge, MA.: Harvard University Press.

Walbott, H. G. (1991). Recognition of emotion from facial expression via imitation? Some evidence for an old theory. *British Journal of Social Psychology*, *30*, 207–219.

Watt, R. J., & Ash, R. L. (1998). A psychological investigation of meaning in music. *Musicae Scientiae*, *1*, 1–27.

Waxer, L. A. (2002). *The city of musical memory: Salsa, record grooves and popular culture in Cali, Colombia*. Middletown, CT: Wesleyan University Press.

Weiner, B., & Graham, S. (1984). An attributional approach to emotional development. In C. E. Izard, J. Kagan, & R. B. Zajonc (Eds.), *Emotions, cognition, and behavior* (pp. 167–191). New York: Cambridge University Press.

Weninger, F., Eyben, F., Schuller, B. W., Mortillaro, M., & Scherer, K. R. (2013). On the acoustics of emotion in audio: What speech, music, and sound have in common. *Frontiers in Psychology*, *4*(May), 1–12. http://doi.org/10.3389/fpsyg.2013.00292

Werker, J. F., Pegg, J. E., & Mcleod, P. J. (1994). A Cross-Language lnvestigation of Infant Preference for Infant-Directed Communication. *Infant Behavior and Development*, *17*, 323–333.

Widen, S. C., & Russell, J. A. (2008). Young children's understanding of others' emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (pp. 348–363). New York: Guilford Press.

Wiens, S. (2005). Interoception in emotional experience. *Current Opinion in Neurology*, *18*(4), 442–7. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16003122

Wild, B., Erb, M., & Bartels, M. (2001). Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: Quality, quantity, time course and gender differences. *Psychiatry Research*, *102*(2), 109–124. http://doi.org/10.1016/S0165-1781(01)00225-6

Will, U., & Turow, G. (2011). Introduction to entrainment and cognitive ethnomusicology. In J. Berger & G. Turow (Eds.), *Music, Science, and the Rhythmic Brain: Cultural and Clinical Implications* (pp. 3–30). New York: Routledge.

Wilson, M., & Knoblich, G. (2005). The case for motor involvement in perceiving conspecifics. *Psychological Bulletin*, *131*(3), 460–473. http://doi.org/10.1037/0033-2909.131.3.460

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Situating emotional experience. *Frontiers in Human Neuroscience*, *7*(November), 764. http://doi.org/10.3389/fnhum.2013.00764

Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. *Neuropsychologia*, *49*(5), 1105–1127. http://doi.org/10.1016/j.neuropsychologia.2010.12.032

Windsor, W. L. (2004). An ecological approach to semiotics. *Journal for the Theory of Social Behaviour*, *34*(2), 179–198. http://doi.org/10.1111/j.0021-8308.2004.00242.x

Winkielman, P., Berridge, K. C., & Wilbarger, J. L. (2005). Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value. *Personality & Social Psychology Bulletin*, *31*(1), 121–35. http://doi.org/10.1177/0146167204271309

Winkielman, P., Niedenthal, P., Wielgosz, J., Eelen, J., & Kavanagh, L. C. (2015). Embodiment of cognition and emotion. In M. . Mikulincer & P. R. Shaver (Eds.), *APA Handbook of Personality and Social Psychology: Vol. 1. Attitudes and Social Cognition.* (Vol. 1, pp. 151–175). American Psychological Association. http://doi.org/10.1037/14341-004

Witek, M. A. G., Clarke, E. F., Wallentin, M., Kringelbach, M. L., & Vuust, P. (2014). Syncopation, body-movement and pleasure in groove music. *PLoS ONE*, *9*(4), e94446. http://doi.org/10.1371/journal.pone.0094446

Wöllner, C. (2012). Is empathy related to the perception of emotional expression in music? A multimodal time-series analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *6*(3), 214–223. http://doi.org/10.1037/a0027392

Zatorre, R. J., & Halpern, A. R. (2005). Mental concerts: Musical imagery and auditory cortex. *Neuron*, *47*(1), 9–12. http://doi.org/10.1016/j.neuron.2005.06.013

Zentner, M. R., & Eerola, T. (2010a). Rhythmic engagement with music in infancy. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(13), 5768–73. http://doi.org/10.1073/pnas.1000121107

Zentner, M. R., & Eerola, T. (2010b). Self-report measures and models. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 185–222). Oxford: Oxford University Press. http://doi.org/10.1017/CBO9781107415324.004

Zentner, M. R., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion*, *8*(4), 494–521. http://doi.org/10.1037/1528-3542.8.4.494

Zentner, M. R., & Kagan, J. (1998). Infants' perception of consonance and dissonance in music. *Infant Behavior and Development*, *21*(3), 483–492. http://doi.org/10.1016/S0163-6383(98)90021-2

Musical pieces used in experiments 2 and 3

Herrman, B., & Bernstein, E. (1991). Max. *On Cape Fear (Original Motion Picture Soundtrack)* [CD]. Santa Monica, CA.: Spectrum Audio.

Portman, R. (2005). Oliver learns the hard way. *On Oliver Twist (Original Motion Picture Soundtrack)* [CD]. London: Sony Classical.

Yared, G. (1997). Kip's Lights. On The English *Patient (Original Motion Picture Soundtrack)* [CD]. San Francisco, CA: Fantasy.

Appendix 1:

Complementary tables from Experiment 2: The role of embodied simulation and semantic associations in emotional contagion with music (Chapter 7)

Table 10.1 *Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Sadness / Tenderness piece*

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	123	2.09	1.23
	Sad, Sorrowful	123	0.97	1.05
	Soothed, Serene	123	2.16	1.18
	Nostalgic, Longing	123	1.89	1.30
	Happy, Cheerful	123	1.40	1.08
	Anxious, Scared	123	0.18	0.48
	Triumphant, Strong	123	0.56	0.96
	Filled with Admiration, with Wonder, Overwhelmed	123	1.28	1.12
	Inspired, with feelings of Transcendence, of Spirituality	123	1.53	1.22
	Irritated, Frustrated	123	0.27	0.67
	Uninterested, Indifferent	123	0.28	0.67
	Valence	124	2.02	1.46
	Tense Arousal (Relaxation)	124	2.12	1.45
	Energy Arousal (Wakefulness)	124	0.03	1.61
Perceived Affective States	Anger	123	0.04	0.20
	Boredom, Apathy	123	0.23	0.56
	Fear, Dread	123	0.21	0.48
	Joy, Amusement	123	0.98	1.01
	Longing, Reminiscence	123	2.47	1.22
	Melancholy, Misery	123	1.32	1.22
	Pride	123	0.52	0.83
	Spirituality, Otherworldliness	123	1.72	1.17
	Tenderness	123	2.47	1.01
	Peacefulness	123	2.60	1.04
	Perceived Valence	124	1.64	1.53
	Perceived Tense arousal	124	2.33	1.32
	Perceived Energy arousal	124	-0.29	1.32

Table 10.2 **Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in the Sadness / Tenderness piece**

	n	Mean	Std. Deviation
Needing to be comforted	114	0.94	1.05
Wanting to dance	114	0.79	1.10
Feeling like everything is fine	114	2.17	1.17
Not being able to concentrate	114	0.61	0.95
Wanting to avoid the situation	114	0.37	0.80
Wanting to hide away	114	0.37	0.74
Wanting to attack something	114	0.06	0.36
Wanting to make the experience longer	114	1.96	1.32
Wanting to understand more	114	1.70	1.23
Feeling like things do not involve me	114	0.67	0.97
Feeling like crying	114	0.61	0.91
Boiling	114	0.12	0.44
Feeling in command of the situation	114	1.10	1.07
Feeling frozen	114	0.30	0.69
Wanting to jump around	114	0.18	0.57
Feeling like laughing	114	0.35	0.62

Table 10.3 *Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Fear / Anger piece*

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	124	0.16	0.39
	Sad, Sorrowful	124	0.80	1.00
	Soothed, Serene	124	0.22	0.63
	Nostalgic, Longing	124	0.30	0.66
	Happy, Cheerful	124	0.41	0.71
	Anxious, Scared	124	1.60	1.34
	Triumphant, Strong	124	1.53	1.34
	Filled with Admiration, with Wonder, Overwhelmed	124	0.98	1.09
	Inspired, with feelings of Transcendence, of Spirituality	124	0.51	0.98
	Irritated, Frustrated	124	0.93	1.11
	Uninterested, Indifferent	124	0.29	0.62
	Valence	124	-0.43	1.89
	Tense Arousal (Relaxation)	124	-1.19	1.93
	Energy Arousal (Wakefulness)	124	1.78	1.33
Perceived Affective States	Anger	124	2.06	1.25
	Boredom, Apathy	124	0.09	0.31
	Fear, Dread	124	2.69	1.19
	Joy, Amusement	124	0.24	0.59
	Longing, Reminiscence	124	0.37	0.76
	Melancholy, Misery	124	1.13	1.03
	Pride	124	2.44	1.33
	Spirituality, Otherworldliness	124	0.99	1.16
	Tenderness	124	0.15	0.45
	Peacefulness	124	0.14	0.47
	Perceived Valence	124	2.06	1.25
	Perceived Tense arousal	124	0.09	0.31
	Perceived Energy arousal	124	2.69	1.19

Table 10.4 *Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in the Fear /Anger piece*

	n	Mean	Std. Deviation
Needing to be comforted	124	0.73	1.08
Wanting to dance	124	0.22	0.61
Feeling like everything is fine	115	0.82	1.10
Not being able to concentrate	115	1.28	1.19
Wanting to avoid the situation	115	1.30	1.39
Wanting to hide away	115	1.50	1.35
Wanting to attack something	115	0.74	1.08
Wanting to make the experience longer	115	0.97	1.10
Wanting to understand more	115	1.57	1.24
Feeling like things do not involve me	115	0.73	1.03
Feeling like crying	115	0.32	0.63
Boiling	115	0.71	1.06
Feeling in command of the situation	115	0.94	1.05
Feeling frozen	115	0.95	1.02
Wanting to jump around	115	0.35	0.78
Feeling like laughing	115	0.31	0.75

Table 10.5 *Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Joy piece*

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	124	1.42	1.08
	Sad, Sorrowful	124	0.07	0.34
	Soothed, Serene	124	1.52	1.03
	Nostalgic, Longing	124	0.90	1.04
	Happy, Cheerful	124	2.69	1.02
	Anxious, Scared	124	0.10	0.35
	Triumphant, Strong	124	1.69	1.28
	Filled with Admiration, with Wonder, Overwhelmed	124	1.40	1.22
	Inspired, with feelings of Transcendence, of Spirituality	124	1.06	1.24
	Irritated, Frustrated	124	0.12	0.43
	Uninterested, Indifferent	124	0.19	0.48
	Valence	124	2.69	1.03
	Tense Arousal (Relaxation)	124	1.87	1.43
	Energy Arousal (Wakefulness)	124	2.31	1.40
Perceived Affective States	Anger	124	0.09	0.36
	Boredom, Apathy	124	0.07	0.34
	Fear, Dread	124	0.04	0.20
	Joy, Amusement	124	2.73	1.06
	Longing, Reminiscence	124	0.95	0.99
	Melancholy, Misery	124	0.20	0.54
	Pride	124	1.48	1.17
	Spirituality, Otherworldliness	124	1.20	1.20
	Tenderness	124	1.39	1.09
	Peacefulness	124	1.69	1.24
	Perceived Valence	124	2.83	1.11
	Perceived Tense arousal	124	1.33	1.57
	Perceived Energy arousal	124	2.06	1.29

Table 10.6 *Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in Joy piece:*

	n	Mean	Std. Deviation
Needing to be comforted	124	.17	0.59
Wanting to dance	124	1.85	1.36
Feeling like everything is fine	115	2.68	0.99
Not being able to concentrate	115	.65	0.90
Wanting to avoid the situation	115	.21	0.54
Wanting to hide away	115	.06	0.33
Wanting to attack something	115	.09	0.45
Wanting to make the experience longer	115	2.13	1.37
Wanting to understand more	115	2.02	1.29
Feeling like things do not involve me	115	.61	0.91
Feeling like crying	115	.03	0.16
Boiling	115	.19	0.56
Feeling in command of the situation	115	1.74	1.20
Feeling frozen	115	.07	0.32
Wanting to jump around	115	1.63	1.38
Feeling like laughing	115	1.53	1.24

Table 10.7 *Correlations between scores of Perceived Emotions and Induced Emotions in Sadness / Tenderness piece*

	Perceived Emotions									
Induced Emotions	Tenderness	Melancholy	Peacefulness	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Mellowed	.56**	.02	.55**	.24**	.20*	-.05	.01	-.19*	.25**	.09
Sad	.19*	.54**	-.15	.28**	-.37**	.31**	-.14	.06	-.03	.11
Soothed	.32**	-.22*	.60**	.12	.32**	-.15	.03	-.14	.44**	-.04
Nostalgic	.32**	.32**	.12	.42**	-.09	.24**	-.04	-.01	.19*	.11
Happy	.31**	-.38**	.43**	.02	.50**	-.16	.23*	-.09	.33**	-.13
Anxious	.00	.33**	-.16	.08	-.25**	.31**	-.03	.03	-.16	.06
Triumphant	-.03	-.08	.09	-.19*	.27**	.10	.49**	.05	.23*	-.04
Irritated	-.07	.19*	-.15	-.04	.02	.13	.08	.33**	-.03	.11
Transcendent	.28**	-.05	.41**	.08	.23*	.10	.03	.03	.67**	.10
Admiring	.35**	-.16	.35**	.09	.32**	-.02	.19*	-.17	.37**	.06
Uninterested	-.16	.10	-.15	.02	-.10	-.07	-.10	.00	-.16	.21*

Statistic: Spearman's Rho.

** p < .05, ** p < .001*

Table 10.8 *Correlations between scores of Perceived Emotions and Induced Emotions in Fear/ Anger piece*

		Perceived Emotions									
		Tenderness	Melancholy	Peacefulness	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Induced Emotions	Mellowed	.29**	-.11	.33**	.26**	.41**	-.15	.12	-.17	.18	-.03
	Sad	.15	.46**	.03	.29**	-.02	.10	.01	.19*	.02	.27**
	Soothed	.32**	-.16	.43**	.10	.38**	-.13	.05	-.11	.14	.05
	Nostalgic	.44**	.28**	.17	.59**	.14	-.04	.24**	.09	.26**	.21*
	Happy	.33**	-.07	.35**	.26**	.43**	-.10	.24**	.02	.22*	-.04
	Anxious	.04	.20*	-.21*	.04	-.17	.42**	-.02	.28**	-.05	.13
	Trium-phant	.18*	.10	.24**	.31**	.25**	-.16	.42**	.04	.22*	-.08
	Irritated	.16	.14	-.18*	.08	-.08	.19*	.09	.41**	-.20*	.33**
	Trans-cendent	.43**	.08	.19*	.34**	.34**	-.09	.41**	-.04	.58**	.03
	Admiring	.26*	-.03	.26**	.30**	.20*	-.15	.33**	.00	.30**	.02
	Unin-terested	-.07	.17	-.04	-.07	.02	.11	-.08	.02	-.13	.20*

Statistic: Spearman's Rho.

N = 124

** p < .05, ** p < .001*

Table 10.9 *Correlations between scores of Perceived Emotions and Induced Emotions in Joy piece*

		Perceived Emotions									
		Tenderness	Melancholy	Peacefulness	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Induced Emotions	Mellowed	.40**	.04	.47**	.20*	.25**	-.09	-.01	-.28**	.33**	.10
	Sad	.17	.11	.11	.22*	.07	.13	.12	-.06	.22*	-.06
	Soothed	.48**	-.05	.63**	.35**	.36**	-.14	.17	-.24**	.42**	.20*
	Nostalgic	.37**	.23**	.31**	.52**	.23*	-.03	.14	-.13	.24**	.33**
	Happy	.32**	-.16	.27**	.15	.62**	-.15	.13	-.28**	.14	-.03
	Anxious	-.13	.13	-.22*	.01	-.13	.09	.00	.40**	-.08	.07
	Triumphant	.17	.02	.15	.12	.23**	.08	.52**	.01	.13	.09
	Irritated	-.04	-.05	-.09	-.10	-.16	.08	-.07	.52**	-.05	-.07
	Transcendent	.46**	.10	.53**	.28**	.26**	.00	.22*	-.11	.65**	.14
	Admiring	.39**	.13	.45**	.38**	.32**	.01	.36**	-.05	.56**	.15
	Uninterested	-.05	.20*	.05	.00	-.10	-.09	.02	.08	.04	.11

Statistic: Spearman's Rho.

$N = 124$

** = $p < .05$, **= $p < .001$*

Appendix 2:

Transcription of user interface and questionnaires from the web-based experiment: Simulation, extra-musical information and empathy (Chapter 8)

Page 1: Welcome

Thank you for agreeing to take part in this study, which has been approved by the Ethics Committee of the Department of Music at the University of Sheffield.

This research seeks to investigate people's psychological experiences with instrumental music. Your participation in the study will involve listening to three pieces of music while doing a mental task, and then answering several questionnaires after each one. This is estimated to take approximately 15-20 minutes to complete. All information collected in this study will remain confidential and anonymous. You will not be asked to provide any personal details that could be used to identify you. While your participation in the study is greatly appreciated, you are free to withdraw from this study at any time by simply closing the browser window.

If you have any questions or concerns please contact Julian Céspedes-Guevara on 07568188 562 / mup04jc@sheffield.ac.uk or Professor Nicola Dibben at nj.dibben@sheffield.ac.uk, who will be happy to discuss these with you.

By going on to answer the following questionnaire you are giving your informed consent to participate. Please click on the 'NEXT' button to proceed.

Page 2: Important Information before starting the Experiment

It is strongly recommended that you take the survey in a quiet environment, and that you listen to the music with headphones. The experiment has to be completed individually, you should not discuss your answers with anyone else. Please make sure that you do the whole experiment without any interruptions, and not doing anything else at the same time. (For example, surfing the web, talking with another person, answering your phone, sending a text message, etc.) It is essential that you keep your concentration focused on the experiment all the time.

If you are sure you can do the experiment under these conditions at this moment, please click on the 'NEXT' button to continue. If you prefer, you can come back and do the experiment at some other time by clicking on the link in the invitation e-mail.

Page 3: Practice

Before you do the actual experiment, we will have a short practice so you become familiar with the procedure. The task is very simple, it consists of three parts: Read the description about the piece that you will listen to, Listen to the piece, while imagining that you are one of the musicians who plays the piece. (You can choose to imagine playing only one of the instruments, or if you prefer, you can imagine switching from one instrument to the other as the music progresses). Please avoid moving, tapping, dancing or singing while listening to the music. The piece will sound two times, with a small pause in the middle. You can close your eyes, if you find this helps you concentrate.

Please click on the "Next" button to practice this exercise.

Page 4: You will now listen to a fragment of a musical piece, twice. Please listen to the piece, while imagining that you are the musician playing the piece. Please avoid moving, tapping, dancing or singing while listening to the music. Click on the Icon to hear the music. (The file will be played in a new window)

Page 5:

1. You probably perceived that the piece you just listened to communicated some feelings or emotions, as if they were somehow in the music. (For example, that the piece was expressive of: melancholy, tenderness, peacefulness, love, etc.) Please click here if you had the experience of perceiving that the previous piece of music communicated or expressed an emotion: (Select one option)

- ○ Yes, I perceived that this piece expressed an emotion.
- ○ No, I did not perceive that this piece expressed an emotion.
- ○ I am not sure

2. On the other hand, it is also possible that your emotional state changed while listening to the music. (For example, it is possible that you felt more or less relaxed, mellowed, nostalgic, sad, etc., after listening to the piece than before). Please click here if your emotional state changed while listening to the music: (Select one option)

- ○ Yes, my emotional state changed while listening to the music.
- ○ No, my emotional state did not change while listening to the music.
- ○ I am not sure

Page 6:

Before we start the experiment, it is important to check how you are feeling now, in case this affects your performance.

3. Please indicate how you are feeling right now

	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) Pleasant, Well (Select one option)	○	○	○	○	○
*(b) Unpleasant, Bad (Select one option)	○	○	○	○	○
*(c) Tense, Jittery (Select one option)	○	○	○	○	○
*(d) Relaxed, At ease (Select one option)	○	○	○	○	○
*(e) Sleepy, Drowsy (Select one option)	○	○	○	○	○

We are now ready to start the experiment. Please click on the 'NEXT' button to proceed.

Page 7: Description of the piece you will listen to

The composer wrote this piece towards the middle of his career, in what proved to be one of the most difficult years of his life. His young wife died while giving birth to their first child, and a few months later he had to leave his position as lecturer of composition in a prestigious university and travel to a different country as a political refugee, because the start of war in his home country made the political climate too dangerous to remain there.

Page 8: *Please listen to the piece, while imagining that you are one of the musicians playing the piece. Please avoid moving, tapping, dancing or singing while listening to the music. Click on the Icon to hear the music. (The file will be played in a new window)*

Page 9: Now some questions about your listening experience... Please indicate to what extent you felt the following sensations or urges while listening to the last piece of music:

4. Please select an option for each row					
	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) Like I wanted to listen more, to make the experience longer (Select one option)	○	○	○	○	○
*(b) Like I didn't want to have anything to do with the situation, like staying away from it (Select one option)	○	○	○	○	○
*(c) Like I wanted to understand or learn more about the situation (Select one option)	○	○	○	○	○
*(d) Like things going on did not involve me, like not paying attention to them (Select one option)	○	○	○	○	○
*(e) Like crying (Select one option)	○	○	○	○	○
*(f) Like a need to be comforted, like needing a hug (Select one option)	○	○	○	○	○
*(g) Like I wanted to attack something (Select one option)	○	○	○	○	○
*(h) Like I was boiling inside (Select one option)	○	○	○	○	○
*(i) Like I was in command of the situation (Select one option)	○	○	○	○	○
*(j) Like I needed to protect myself, like hiding away (Select one option)	○	○	○	○	○
*(k) Like I was paralysed, frozen (Select one option)	○	○	○	○	○
*(l) Like I could not concentrate or order my thoughts (Select one option)	○	○	○	○	○
*(m) Like bouncing around or dancing (Select one option)	○	○	○	○	○
*(n) Like laughing (Select one option)	○	○	○	○	○
*(o) Like everything was fine (Select one option)	○	○	○	○	○

Page 10: Please rate the intensity with which YOU FELT each of the following feelings while listening to the last piece of music: Do not describe the music (e.g., "this music is sad") or what the music may be expressive of (e.g., "this music expresses joy"). Describe YOUR OWN feelings while listening to the music.

5. Please select an option for each row					
	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) Pleasant, well (Select one option)	○	○	○	○	○
*(b) Unpleasant, Bad (Select one option)	○	○	○	○	○
*(c) Tense, Jittery (Select one option)	○	○	○	○	○
*(d) Relaxed, At ease (Select one option)	○	○	○	○	○
*(e) Awake, Energized (Select one option)	○	○	○	○	○
*(f) Sleepy, Drowsy (Select one option)	○	○	○	○	○
*(g) Mellowed, Softened-up, Affectionate (Select one option)	○	○	○	○	○
*(h) Sad, Sorrowful (Select one option)	○	○	○	○	○
*(i) Soothed, Serene (Select one option)	○	○	○	○	○
*(j) Nostalgic, Longing (Select one option)	○	○	○	○	○
*(k) Happy, Cheerful (Select one option)	○	○	○	○	○
*(l) Anxious, Scared (Select one option)	○	○	○	○	○
*(m) Triumphant, Strong (Select one option)	○	○	○	○	○
*(n) Filled with Admiration, with Wonder, Awed, Overwhelmed (Select one option)	○	○	○	○	○
*(o) Inspired, with feelings of Transcendence, of Spirituality (Select one option)	○	○	○	○	○
*(p) Irritated, Frustrated (Select one option)	○	○	○	○	○
*(q) Uninterested, Bored (Select one option)	○	○	○	○	○

Page 11: Please rate the extent to which you perceived that the last piece of music EXPRESSED or COMMUNICATED the following feelings: DO NOT RATE YOUR OWN feelings, use the ratings to describe the feelings REPRESENTED by the music.

6. Please select an option for each row

	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) Positive feelings (Select one option)	○	○	○	○	○
*(b) Negative feelings (Select one option)	○	○	○	○	○
*(c) Peacefulness, Serenity (Select one option)	○	○	○	○	○
*(d) Tension, Unease (Select one option)	○	○	○	○	○
*(e) Alertness, Readiness (Select one option)	○	○	○	○	○
*(f) Tiredness, Weariness (Select one option)	○	○	○	○	○
*(g) Anger, Irritation (Select one option)	○	○	○	○	○
*(h) Boredom, Apathy (Select one option)	○	○	○	○	○
*(i) Fear, Dread (Select one option)	○	○	○	○	○
*(j) Joy, Amusement (Select one option)	○	○	○	○	○
*(k) Longing, Reminiscence (Select one option)	○	○	○	○	○
*(l) Melancholy, Misery (Select one option)	○	○	○	○	○
*(m) Pride, Power (Select one option)	○	○	○	○	○
*(n) Spirituality, Otherworldliness (Select one option)	○	○	○	○	○
*(o) Tenderness, Love (Select one option)	○	○	○	○	○

Page 12:

7. How much did you like the music you just listened to? (Select one option)

- ○ Not at all
- ○ Somewhat
- ○ Moderately
- ○ Quite a lot
- ○ Very much

8. How familiar were you with this piece of music before the experiment? (How well do you know the piece) (Select one option)

- ○ Unfamiliar
- ○ Somewhat familiar
- ○ Very familiar

Please rate your agreement with the following statements about your experience with the music:

9.					
	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) My attention was focused entirely on the listening task, I forgot about everything else while listening to the music (Select one option)	○	○	○	○	○
*(b) I was interrupted and distracted by other things while listening to the music (Select one option)	○	○	○	○	○
*(c) I was able to avoid moving, tapping, dancing or singing while listening to the music (Select one option)	○	○	○	○	○
*(d) I found it difficult to imagine myself playing the instruments I listened to (Select one option)	○	○	○	○	○

Two questions about the people who usually listen to music like the piece you just listened to:

10. Please indicate how you are feeling right now					
	Not at all	Somewhat	Moderately	Quite a lot	Very much
*(a) How much do you consider yourself to be similar to the typical person who enjoys this kind of music? (Select one option)	○	○	○	○	○
(b) Do you think you it would easy for you to befriend someone who loves this kind of music? (Select one option)	○	○	○	○	○

11. Please summarize what went through your mind while you were listening to this piece of music (any thoughts, images, ideas, etc.)

____

Page 25: Finally a few questions about yourself, and your relationship with music

28. What is your age? (Enter a value between 10 and 99)

29. What is your gender (Select one option)

- ○ Female
- ○ Male
- ○ (I prefer not to answer)

30. What is your mother tongue? (First Language) (Select one option)

- ○ English
- ○ Other (Please specify) ___________

31. What is your nationality?

Page 26:

32. I listen attentively to music for the following amount of time per day (Select one option)

- ○ 0 to 15 mins
- ○ 15 to 30 mins
- ○ 30 to 60 mins
- ○ 60 to 90 mins
- ○ 2 hrs
- ○ 2 to
- ○ 3 hrs
- ○ 4 hrs or more

Please rate your agreement with the following statements:

33.							
	Complet -ely disagree	Strongly disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Complet -ely Agree
(a) I spend a lot of my free time doing music-related activities (Select one option)	○	○	○	○	○	○	○
(b) Music is kind of an addiction for me - I couldn't live without it (Select one option)	○	○	○	○	○	○	○
(c) I would not consider myself a musician (Select one option)	○	○	○	○	○	○	○
d) I have never been complimented for my talents as a musical performer (Select one option)	○	○	○	○	○	○	○

34. What type of musical training have you received? (Select one option)

- ○ None
- ○ Self-taught (no formal training)
- ○ Private (individual) music classes/ tuition
- ○ Group music classes / tuition

35. I have had ____ years of formal training on a musical instrument (including voice) during my lifetime (Select one option)

- ○ 0
- ○ 0.5
- ○ 1
- ○ 2
- ○ 3 to 5
- ○ 6 to 9
- ○ 10 or more

36. Which musical instruments can you play? (Including singing)

____

Appendix 3:

Complementary tables from Experiment 3: Simulation, extra-musical information and empathy (Chapter 8)

Table 11.1 *Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Sadness / Tenderness piece*

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	235	2.40	1.27
	Sad, Sorrowful	235	0.99	1.08
	Nostalgic, Longing	235	2.11	1.33
	Happy, Cheerful	235	1.34	1.16
	Anxious, Scared	235	0.20	0.55
	Triumphant, Strong	235	0.62	0.99
	Filled with Admiration, with Wonder, Overwhelmed	235	1.38	1.33
	Inspired, with feelings of Transcendence, of Spirituality	235	1.71	1.35
	Irritated, Frustrated	235	0.15	0.49
	Uninterested, Indifferent	235	0.36	0.86
	Valence	235	2.08	1.38
	Tense Arousal (Relaxation)	235	2.24	1.44
	Energy Arousal (Wakefulness)	235	-0.11	1.63
Perceived Affective States	Anger	235	0.09	0.39
	Boredom, Apathy	235	0.23	0.66
	Fear, Dread	235	0.24	0.61
	Joy, Amusement	235	1.01	1.12
	Longing, Reminiscence	235	2.49	1.24
	Melancholy, Misery	235	1.42	1.32
	Pride	235	0.43	0.80
	Spirituality, Otherworldliness	235	1.97	1.34
	Tenderness	235	2.80	1.11
	Perceived Valence	235	1.81	1.68
	Perceived Tense arousal	235	2.29	1.56
	Perceived Energy arousal	235	-0.34	1.15

Table 11.2 ***Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in the Sadness / Tenderness piece:***

	n	**Mean**	**Std. Deviation**
Needing to be comforted	235	1.05	1.20
Wanting to dance	235	0.26	0.65
Feeling like everything is fine	235	2.14	1.30
Not being able to concentrate	235	0.51	0.97
Wanting to avoid the situation	235	0.32	0.78
Wanting to hide away	235	0.26	0.66
Wanting to attack something	235	0.02	0.13
Wanting to make the experience longer	235	2.24	1.41
Wanting to understand more	235	1.83	1.25
Feeling like things do not involve me	235	0.55	0.98
Feeling like crying	235	0.77	1.01
Boiling	235	0.15	0.55
Feeling in command of the situation	235	1.46	1.34
Feeling frozen	235	0.39	0.79
Feeling like laughing	235	0.34	0.78

Table 11.3 ***Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Fear / Anger piece***

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	235	0.10	0.39
	Sad, Sorrowful	235	0.87	1.03
	Nostalgic, Longing	235	0.33	0.73
	Happy, Cheerful	235	0.20	0.55
	Anxious, Scared	235	2.09	1.35
	Triumphant, Strong	235	0.89	1.20
	Filled with Admiration, with Wonder, Overwhelmed	235	0.69	1.01
	Inspired, with feelings of Transcendence, of Spirituality	235	0.43	0.84
	Irritated, Frustrated	235	1.03	1.19
	Uninterested, Indifferent	235	0.30	0.77
	Valence	235	-0.81	1.87
	Tense Arousal (Relaxation)	235	-1.88	1.60
	Energy Arousal (Wakefulness)	235	1.26	1.46
Perceived Affective States	Anger	235	1.96	1.30
	Boredom, Apathy	235	0.13	0.49
	Fear, Dread	235	2.85	1.24
	Joy, Amusement	235	0.08	0.32
	Longing, Reminiscence	235	0.44	0.78
	Melancholy, Misery	235	1.31	1.28
	Pride	235	1.82	1.44
	Spirituality, Otherworldliness	235	0.43	0.82
	Tenderness	235	0.08	0.40
	Perceived Valence	235	-2.17	1.63
	Perceived Tense arousal	235	-3.08	1.15
	Perceived Energy arousal	235	2.05	1.57

Table 11.4 ***Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in the Fear /Anger piece:***

	n	Mean	Std. Deviation
Needing to be comforted	235	0.64	1.09
Wanting to dance	235	0.06	0.33
Feeling like everything is fine	235	0.27	0.63
Not being able to concentrate	235	1.01	1.23
Wanting to avoid the situation	235	1.49	1.45
Wanting to hide away	235	1.98	1.36
Wanting to attack something	235	0.84	1.15
Wanting to make the experience longer	235	1.18	1.33
Wanting to understand more	235	1.58	1.31
Feeling like things do not involve me	235	0.54	0.97
Feeling like crying	235	0.40	0.85
Boiling	235	0.87	1.09
Feeling in command of the situation	235	0.77	1.10
Feeling frozen	235	1.17	1.18
Feeling like laughing	235	0.06	0.31

Table 11.5 ***Means and Standard Deviations of Induced and Perceived emotions and Core Affect in Joy / Determination piece***

		n	Mean	Std. Deviation
Induced Affective States	Mellowed, Softened-up, Affectionate	235	1.00	1.16
	Sad, Sorrowful	235	0.06	0.28
	Nostalgic, Longing	235	0.57	0.94
	Happy, Cheerful	235	2.58	1.18
	Anxious, Scared	235	0.14	0.48
	Triumphant, Strong	235	1.81	1.36
	Filled with Admiration, with Wonder, Overwhelmed	235	1.38	1.27
	Inspired, with feelings of Transcendence, of Spirituality	235	1.06	1.18
	Irritated, Frustrated	235	0.15	0.59
	Uninterested, Indifferent	235	0.33	0.85
	Valence	235	2.64	1.23
	Tense Arousal (Relaxation)	235	1.60	1.59
	Energy Arousal (Wakefulness)	235	2.01	1.58
Perceived Affective States	Anger	235	0.06	0.31
	Boredom, Apathy	235	0.09	0.42
	Fear, Dread	235	0.06	0.25
	Joy, Amusement	235	2.69	1.23
	Longing, Reminiscence	235	0.73	0.94
	Melancholy, Misery	235	0.13	0.40
	Pride	235	1.51	1.32
	Spirituality, Otherworldliness	235	0.97	1.12
	Tenderness	235	1.00	1.01
	Perceived Valence	235	2.81	1.12
	Perceived Tense arousal	235	1.06	1.47
	Perceived Energy arousal	235	1.56	1.41

Table 11.6 ***Means and Standard Deviations of scores from the Subjective Feelings and Action Tendencies questionnaire in Joy / Determination piece:***

	n	Mean	Std. Deviation
Needing to be comforted	235	0.06	0.29
Wanting to dance	235	2.01	1.35
Feeling like everything is fine	235	2.71	1.09
Not being able to concentrate	235	0.57	1.02
Wanting to avoid the situation	235	0.15	0.54
Wanting to hide away	235	0.11	0.44
Wanting to attack something	235	0.12	0.46
Wanting to make the experience longer	235	2.18	1.38
Wanting to understand more	235	1.86	1.34
Feeling like things do not involve me	235	0.41	0.83
Feeling like crying	235	0.03	0.23
Boiling	235	0.23	0.62
Feeling in command of the situation	235	1.99	1.36
Feeling frozen	235	0.07	0.31
Feeling like laughing	235	1.20	1.16

Table 11.7 ***Correlations between scores of Perceived Emotions and Induced Emotions in Sadness / Tenderness piece***

		Perceived Emotions								
		Tenderness	Melancholy	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Induced Emotions	Mellowed	.57**	.01	.32**	.29**	-.05	.18**	.03	.37**	-.15*
	Sad	-.07	.52**	.28**	-.23**	.30**	.04	.16*	.05	.00
	Nostalgic	.20**	.28**	.55**	.01	.01	.13	.07	.27**	.03
	Happy	.39	-.24**	-.01	.59**	-.14*	.42**	-.06	.29**	-.03
	Anxious	-.09	.21**	.13**	-.13	.42**	-.01	.25*	-.12	.07
	Triumphant	.22**	-.10	.03	.43**	-.03	.51**	.16*	.34**	.07
	Irritated	-.03	.04	.04	-.04	.13*	-.04	.04	-.07	.23**
	Trans-cendent	.41**	-.02	.21**	.28**	-.02	.25**	.09	.69**	-.16
	Admiring	.35**	-.04	.16*	.34**	.07	.28**	.18**	.51**	-.08
	Unin-terested	-.10	-.02	-.01	.07	.07	-.03	-.07	-.03	.36**

Statistic: Spearman's Rho.

N= 235

** p < .05, ** p < .001*

Table 11.8 ***Correlations between scores of Perceived Emotions and Induced Emotions in Fear/ Anger piece***

		Perceived Emotions								
		Tenderness	Melancholy	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Induced Emotions	Mellowed	.31**	.09	.26**	.05	.03	.08	.10	.30**	.03
	Sad	.01	.52**	.29**	-.08	.36**	.10	.27**	.09	.09
	Nostalgic	.13*	.26**	.49**	.08	.05	.06	.10	.19**	.03
	Happy	.19**	-.06	.12	.37**	-.15*	.21**	-.10	.18**	.03
	Anxious	-.09	.16*	.08	-.12	.46**	.00	.27**	-.12	.10
	Triumphant	.11	.03	.21**	.24**	-.14*	.45**	.19**	.20**	.01
	Irritated	-.07	.23**	.12	-.06	.31**	.12	.49**	-.07	.18**
	Transcendent	.18**	.07	.33**	.15*	-.12	.25**	.06	.48**	.06
	Admiring	.26**	.01	.17**	.27**	-.08	.30**	.08	.29**	.00
	Uninterested	.00	.10	.06	.02	-.04	-.01	.07	-.07	.34**

Statistic: Spearman's Rho.

N = 235

** p < .05, ** p < .001*

Table 11.9 *Correlations between scores of Perceived Emotions and Induced Emotions in Joy piece*

		Perceived Emotions								
		Tenderness	Melancholy	Longing	Joy	Fear	Pride	Anger	Spirituality	Boredom
Induced Emotions	Mellowed	.54*	.09	.32**	.29**	-.01	.12	-.03	.36**	-.07
	Sad	.09	.18**	.22**	-.04	-.05	-.04	.25**	.10	.03
	Nostalgic	.24**	.06	.53**	.05	-.03	.22**	.04	.18**	.01
	Happy	.30**	-.11	.10	.65**	.07	.19**	-.10	.26**	-.05
	Anxious	-.05	.10	.00	-.06	.22**	-.01	.41**	.03	.16*
	Triumphant	.19**	-.09	.15*	.39**	.10	.53**	.03	.29**	-.06
	Irritated	-.06	.09	.05	-.10	.06	.11	.32**	-.05	.13*
	Trans-cendent	.38**	.03	.22**	.26**	.10	.22**	.03	.58**	-.12
	Admiring	.34**	-.02	.16*	.30**	.08	.28**	.05	.36**	.02
	Unin-terested	-.01	.16*	.09	-.16*	-.02	-.09	.13*	-.08	.36**

Statistic: Spearman's Rho.

N = 235

** = p < .05, **= p < .001*