The Effect of Temperament Systems on Emotion Induction and Verbal Identification Performance of Makams in Turkish Makam Music

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To Darjin…

List of Papers

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Abstract

There are various musical features that are yet to be studied in music with regard to cognitive processing and emotional meaning. This thesis aimed to explore one of these features – the effect of the temperament system on emotion induction and verbal identification performance in Turkish makam music. In particular, employing the assumptions of statistical learning in music and music expectation theories which argue that listeners anticipate most strongly the sound sequences to which they have been most frequently exposed. This exploratory aim was investigated in three different experiments. The first experiment explored whether presenting an unfamiliar tonal context within a culturally and formally familiar and unfamiliar temperament system might cause different reactions in terms of the emotion induction of that unfamiliar tonal context and verbal identification of presented musical structure. Moreover, the first experiment also served as a pilot study that tested the thesis's preliminary predictions and the proposed method. The second experiment investigated the first experiments' findings by extending exposure time and using novel stimuli. Furthermore, Experiment 2 also included another experimental paradigm to test whether the surrounding musical/cultural environment might affect the participants' experience of temperament systems even though they were educated in the Western music tradition. While the previous two experiments indicated a potential effect of veridical expectations while experiencing temperament systems, the third experiment aimed to explore the existence of temperament systems in schematic expectations. Overall, the findings of the thesis indicated that the intensity of emotions differed according to the familiar and unfamiliar temperament systems; familiar temperament systems induced more vitality when compared to unfamiliar temperament systems. Furthermore, the experience of uneasy emotions (e.g. sadness, tension) was congruent between the type of ear training course and type of stimulus temperament. However, the congruency effect was not observed in all conditions and differed according to the ear training course, temperament system and country variables. On the other hand, neither temperament systems nor temperament-based ear training courses influenced the verbal identification performance. Also, the 'goodness-of-fit' ratings indicated that temperament systems might be encoded in schematic memory as a consequence of statistical exposure and might be stronger in smaller intervals and when combined with a familiar syntax. While there were no constant findings that temperament systems are in place in all situations, the findings indicated that temperament systems are a musical component that might independently influence emotion induction in music.

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Author’s Declaration

I declare that this thesis is a presentation of original work, and I am the sole author. This work has not previously been presented for an award at this, or any other, university. All sources are acknowledged as references.

1. Introduction

Over the last decade, the quest to identify the causal components responsible for how mu- sic elicits emotions and why we often tend to prefer and remember 'our own music' has attracted a considerable amount of interest. This interest also materialised in many theories to explain the underlying mechanisms behind those causal components (Huron, 2006; Juslin, 2013a; Juslin & Västfjäll, 2008; Scherer & Coutinho, 2013). Among these components, 'pitch' has been one of the most challenging but also one of the most studied because of definitions on physic-theoretic aspects of pitch such as roughness (Kameoka & Kuriyagawa, 1969; Plomp & Levelt, 1965), harmonicity (McDermott, Lehr & Oxenham, 2010) and cultural aspects such as tonal schema (Balkwill & Thompson, 1999; Curtis & Bharucha, 2009; Krumhansl & Kessler, 1982). According to these studies, a melody in a lower register might induce sadness (Juslin & Lindström, 2010), a simultaneous octave interval might be perceived as positive and strong (Costa, Fine & Ricci Bitti, 2004) as a possible result of consonance conditioning (McDermott, Schultz, Undurraga & Godoy, 2016) or melodies that belong to various modes (in the sense of *heptatonic* representations) might either induce sadness or happiness (Temperley & Tan, 2013). Furthermore, pitch and higher-order pitch structures are also crucial in recognising and memorising various songs (Dowling, Kwak &Andrews, 1995). Moreover, the way we perceive emotions and how we recognise music is often shaped by the surrounding musical culture, which is also a crucial component in forming a mental representation of pitch. Previous studies in music emotion (Ali & Peynircioglu, 2010; Schubert, 2007) and recognition of melodic structures showed that the verbal identifiability of musical structures (Korenman & Peynircioğlu, 2004; Zatorre, 1983; Zatorre & Halpern, 1979) and their recollection (McAuley, Stevens, & Humpreys 2004) are based on the prior knowledge of culture-musical features and can also be acquired by statistical learning (Krumhansl, 2001).

It is clear that pitch is a vital part of listeners' musical memory features and, for this reason, too, familiarity. However, despite the outstanding and comprehensive improvements to the body of pitch research, the result of these foundational findings on emotion induction and verbal identification performance is still not generalised.

The perspective on musical theory and its related psychological theories has been applied only to Western settings and used to scrutinise the notion of unfamiliarity under Western understanding (Huron, 2008). Even though this potentially monocultural tendency has been criticised by many scholars (Huron, 2008; Stevens, 2012), the problems in the forefront of the discipline are not limited to these. For instance, the evaluation of in-culture musical features is often based on *Harmonic Dualism* (Harrison, 1994; Oettingen, 1886; Vogel, 1993), also known as major-minor tonality, without focusing on or investigating the psycho-cultural evolution of Western tonal music. On the other hand, pitch perception is widely regarded as being based on frequency ratios (Moore, 2003), and various temperament systems are based on logarithmic frequency systems; that is, the invariant interval features are frequency ratios rather than frequency differences characteristic of linear systems (Will & Ellis, 1996). Even though Will and Ellis (1994), in their Australian aboriginal linear frequency study, strongly challenged the prevailing frequency ratio (consonance) based on pitch perception assumptions, this alternative approach did not take place in pitch perception knowledge. In addition to these problems of generalisation and approach, there are also musical surface features yet to be investigated. For example, despite being the foundation of pitch relations, to the best of my knowledge, the effect of temperament systems on emotion induction and verbal identification of musical structures has received very limited attention.

In brief, temperament systems can be explained as division approaches of cultures on the octave (2:1). In many cultures, even though the temperament systems exist and it is rationalised by maths, the teaching or exposure of temperament systems is often done through scales that can be identified as a musical structure based on the temperament system of that culture. Therefore, temperament systems could be described as a music-cognitive component that might also be learned unconsciously as a possible result of statistical learning. In order to address the lack of research on this subject, this thesis aims to explore the effect of temperament systems on emotion induction and verbal identification performance of musical structures based on the theory of statistical learning in music (Huron, 2006) and musical expectation assumptions (Meyer, 1956). Accordingly, my assumptions are as follows:

- If statistical learning in music, hence music emotion induction (Huron, 2006), is mainly driven by implicit knowledge-based schemata of surface-level features, and if temperament system is a component of music's surface-level features, we should expect different emotion intensities in an unfamiliar temperament system because of violation of expectation.

- If statistical learning in music is mainly driven by explicit knowledge that is based on recency and slightly by implicit knowledge, we should observe a congruency effect that depends on received stimuli surface-level features.

- If statistical learning in music is a process acquired by most exposed sounds and if implicit knowledge does not play a role in forming expectations, then regardless of culture, we should expect a congruency effect between most exposed surface-level features.

In addition to understanding the effect of temperament systems on emotion induction, I also wanted to test whether temperament systems influence the conceptual categorisation of musical structures (Snyder, 2000) via verbal identification performance. As such, I compared Turkish makam music tradition (OT, pitches unequally divided into 24 intervals, unfamiliar) and Western tonal tradition (ET, equally divided into 12 intervals, familiar), which are very different in terms of their culture-relative meanings on emotions and musical theory approaches.

In order to explore the effect of temperament systems on emotion induction and verbal identification performance of makams (a scale-like musical structure in Turkish Makam music), I conducted three different experiments. Firstly, in order to test preliminary predictions, I carried out a pilot study (Experiment 1) which aimed to explore whether presenting an unfamiliar tonal context within a culturally and formally familiar and unfamiliar temperament system might differ in terms of the emotion induction of that unfamiliar tonal (makam) context and verbal identification of presented musical structure. Furthermore, I aimed to explore whether statistical exposure to a temperament system via ear training courses might change participants' emotional experience and whether it would increase the verbal identification performance of makams. Here, participants were exposed to selected ear training makams and were only informed about the makams that were selected. They were not informed about which temperament system we used in the ear training courses.

In compliance with the results indicated by Experiment 1, I re-conducted the previous experimental paradigm, which differed in length and taught makams (Experiment 2). Furthermore, as an additional experimental paradigm, Experiment 2 included a cross-cultural perspective which aimed to explore whether an *ecological sonic play environment* (Clarke, 2005; Clarke, Dibben & Pitts, 2010) might influence the emotional experience and verbal identification performance of makams by comparing culturally and formally unfamiliar participants with formally unfamiliar but unintentionally familiar participants.

In Experiment 3, since memory is a crucial factor in emotions in music, according to statistical learning in music and musical expectation theory (Huron, 2006), I aimed to understand the effect of temperament systems on schematic expectations by presenting unfamiliar motifs either in a familiar or unfamiliar system by way of priming lower consonance valued intervals. Moreover, I also aimed to understand whether these gained 'goodness-of-fit' ratings might change after a temperament-based ear training course and whether these ratings were congruent with the temperament system employed in ear training courses. Another necessity for Experiment 3 was the findings of two previously conducted experiments which suggested a potentially veridical expectation effect while experiencing the temperament systems.

This thesis also aims to widen and inform the current music perception and cognition body of literature by reporting Turkish makam music's emotional qualities and verbal identification performance and investigating by underlying its pitch-related features through a cross-cultural perspective.

In the first part of this section, I outline the role of pitch in emotion induction and verbal identification performance and briefly explain the present thesis's aim. In the next part of this section, I review the music-theoretical explanations of temperament systems and disagreements on music-theoretical definitions in order to propose a more comprehensive understanding throughout the thesis.

1.1 The Problems in Terminology

The most confusing problem in terminology is the nomenclatures used to describe temperament systems. For instance, temperament systems have been termed 'musical scales', 'musical systems', 'tuning systems' and 'pitch interval' in various studies. An actual distinction has emerged between tuning systems and temperament systems throughout music history. Accordingly, if the derivation of pitches is based on simple ratios, it has been called a tuning system. On the other hand, if any deviation from simple ratios has emerged, and if this deviation has dispersed to the octave, it has been called a temperament system (Rash, 1983).

1.1.1 Ratios or Linear Frequency Position of Pitches?

Ratios typically define the derivation of pitches as a consequence of the historical Pythagorean approach. The Pythagorean approach can be defined as a derivation method based on simple ratios, and inherently/culturally, these simple ratios have been linked to the consonance concept. By establishing the polyphonic style in Western societies, the relation between the ratio and consonance concept became more related and indistinguishable in music theory books such as Hauptmann's Harmony (1853) and in early studies that tried to explain the logical construction behind the music. For instance, Forkel (1788) explained the relationship on the basis of an analogy, arguing that if the language (*Sprache*) is the dress of thoughts, then the melody is the dress of harmony. "Harmony is; thus, he proceeded to say, a kind of logic in music, since it corrects and determines a melody [*melodischensatz*] such that for the sentiments it seems to turn into actual truth" (Forkel, 1788, p. 24). Consequently, intense focus on consonance and vertical harmony also contributed to the neglection of the idea of the linear frequency positions. Consequently, when notes outside of ET are introduced, instead of evaluating within linear frequency relations of a temperament system, they are typically considered aberrations or expressive ornaments rather than notes and scales in themselves (Sethares, 2005).

1.1.2 Scales

Scales are a selected combination of pitches, which occupy different meanings depending on the culture and are part of that culture's temperament system. On the other hand, scales could qualify as a sub-system of the temperament system as well as a parent-system of any finite-state song. While the representation of these systems may differ in terms of the pitch quantity to construct a scale (such as pentatonic scales), these subsystems are prevalent in many cultures. According to Sethares (2005), the driving force behind this commonality is to simplify the performing and composing of musical works, which might also be a consequence of categorical perception.

Aside from the interchangeable usage of temperament systems with scales, a large body of literature refers to the heptatonic concept as diatonic, which is a restricted definition. The diatonic scale is a variation of the heptatonic scale with a combination of two whole tones and one half tone with three whole tones and one half tone (i.e., major scale), which also probabilistically relies on the minimum or maximum division of a whole tone. For instance, in Turkish makam music, a whole tone is principally divided into nine equal pieces, thanks to its pitch derivation method. However, use of these pieces can vary according to the constructed makam concept, which has some similarities and discrepancies with the heptatonic scale concept (for a detailed comparison, see section 2.5.1.4).

1.1.3 Which One: Intonational Naturalism or Intonational Relativism?

On the other hand, the question of whether timbre has defined the temperament systems or whether temperament systems are a cause of timbre is also another ongoing debate on pitch studies. For instance, many temperament investigations (cf. Leung, 2017) have described pitch as a timbral component of a musical system. On the other hand, the body of physics and music theory literature often define the timbre and related intonation notion as a consequence of overtones. Overtones (also known as harmonics) are integer multiples of the fundamental pitch. Although there have been many controversial investigations into the relation of overtones with intonation and timbre, pure intonation (Hauptmann, 1853) or intonational naturalism has dominated the current body of research. Moreover, 'intonational relativism', otherwise known as the "cultural construct for timbre", has been neglected despite strong counterclaims (cf. Perlmann, 1996). In my opinion, the leading cause for this dichotomy is the dominant understanding which sees timbre sources as a 'resonator' rather than a musical expression and communication tool.

Given the historical evolution of temperament and instruments, it is plausible to say that it is rather a coevolution process where each assisted the evolution of the other.

1.2 The Definition of 'Temperament System' throughout the Thesis

First and foremost, in order to overcome any potential culture-specific confusion, I prefer to use the term 'temperament system' over other nomenclatures as it presents a terminological advantage. As such, the following explanation of the temperament system also serves as the main idea of this thesis on temperament systems:

Many musical cultures that share octave equivalence (2:1) define pitches through temperament systems. Temperament systems describe culturally determined and idealised pitch relations (Kopiez, 2003), and usually, these pitch relations are based on consonance (Bibby, 2003). The main difference between cultures is the partition approach of the pitch continuum, and these approaches are mostly based on historically defined ratios such as the Pythagorean 3:2 ratio, which was first documented by Pythagoras. For example, in Western cultures, the most common temperament system is the 12-tone equal-tempered system in which the octave is divided into 12 successive pitch spaces by repeating a 3:2 ratio, each sounding half of the whole tone. Moreover, temperament systems are not only a foundation for pitches; they are also one reference point for the manufacture of instruments and, therefore, timbre.

Figure 1.1 illustrates the hypothetical coevolution of temperament systems. Accordingly, musical works and musical representations take their source from the culture's and family's musical surrounding environment. Then, with the awareness to classify music, the composed musical works become a source for culturally determined pitches. Subsequently, in order to simplify performing and composing, scales are developed. Following that, the temperament systems exist with the desire to ground the music phenomenon on mathematical representations.

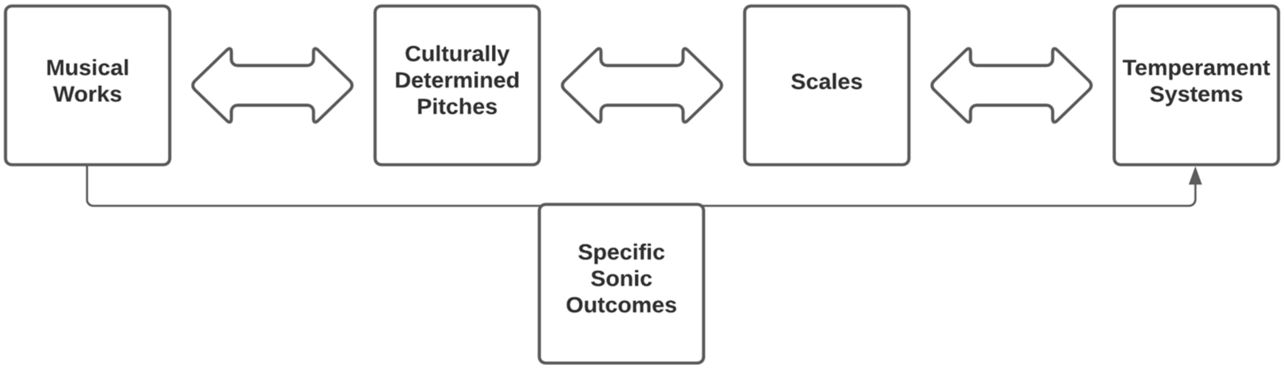


Figure 1.1 The hierarchical order of pitch-related structures in music culture.

1.3 Structure of the Thesis

The second chapter of this thesis will review the theoretical concepts in music emotions and statistical learning in music. In the second part of the second chapter, the temperament system and elaborated information on Turkish makam music will be given. Three different experiments will be presented after explaining the general design in experiments and the selection of the stimulus. Every experiment is presented in an article format and includes its own discussion sections that evaluate experiment-specific findings. In Experiment 1, the emotional experience of familiar and unfamiliar temperament systems and the effect of temperament-based ear training on emotion induction and verbal identification performance were tested and discussed according to findings. Experiment 2 also investigated the effect of temperament systems on emotion induction and verbal identification performance. In Experiment 2, the discussion will mainly focus on the congruent and incongruent findings between Experiment 1 and Experiment 2. In Experiment 3, temperament systems' existence in schematic expectations was tested through a modified version of the probe-tone paradigm (Krumhansl & Kessler, 1982). Finally, the thesis will close with a general and elaborate discussion and conclusion of all findings and an outlook on future research directions.

2. Background

2.1 Emotion

Emotions have often been a vital and guiding experience in human life in all situations. However, the definition of emotion has often been a subject of debate on a scientific level. The main reason for this unintentional diversity is often attributed to the miscellaneous structure of emotions and the complexity of experiencing emotions shaped by ecology and culture. For instance, responses to the same stimuli tend to differ on an individual level, and they can also provoke different physiological activities. Even though the diverse experiential and individual differences on emotions would not make it possible to define a comprising definition, according to the American Psychology Association dictionary, emotion is "a complex reaction pattern, involving experiential, behavioural, and physiological elements, by which an individual attempts to deal with a personally significant matter or event" (VandenBos & APA, 2007)

Its centralness, cognitiveness and evaluative appraisals have primarily distinguished the definition of emotion from the other related structures such as feelings or moods (Nussbaum, 2001). In addition to many classifications the vast majority of literature on emotions characterises primary, core, blue-ribbon or basic emotions resulting from the biological origin and adaptive function (Ekman, 2003; Darwin, 1872/1998; Tomkins, 1968). Secondary processes such as learning and experience might also shape this emotional experience (Panksepp, 2011) and are termed as higher cognitive emotions (Griffiths, 1997). The theories in order to explain the causality behind emotions are often based on two main categories: cognitivist and somatic feelings and, as a more recent category, hybrid approaches of these two main categories. The pure somatic feeling theories of emotion mainly construe physiological changes as consequences of emotion (Damasio, 1994; Darwin, 1872/1998; James, 1884). On the other hand, the pure cognitivist theories of emotion construe the emotion as a consequence of a representation of a proposition and an attitude toward that proposition (Prinz, 2004). The hybrid approaches on emotions are basically merging these two basic main categories by including perspectives from social and developmental psychology (e.g., Lyon's cognition and feeling theory, 1980). Current psychology and philosophy researchers have more or less of a consensus on what emotions are considered to comprise or involve. These are thoughts (e.g., desires) (Arnold, 1960), mental processes (e.g., memory) (Oatley & Johnson-Laird, 1987), categorisation (Barrett, 2009), subjective feelings (Ledwig, 2006), physiological responses (DeLancey, 2002; James, 1884), action tendencies (Frijda, 1986) and imagination (Morton, 2013). However, it is worth noting that these theories also differ in how they think the class of emotions or emotional phenomena should be internally structured. For example, while some theorists believe that emotions are a hardwired structure (Ekman, 2004), some theorists deny the idea of universality and focus on the social construct's effect (Solomon, 1977).

Much effort has been made to create or conclude a more comprehensive explanation of emotion causal mechanisms in literature. For instance, in order to define the term "emotion" and to cover all related processes and approaches under one umbrella, Moors (2010) has suggested that using the term "emotion episode" would indicate anything starting from the stimulus to the later components or the immediate consequences of the emotion. The components (Scherer, 2005) are: (a) a cognitive component; (b) a feeling component, referring to emotional experience; (c) a motivational component, referring to tendencies to flee or fight; (d) a somatic component, referring to physiological responses; (e) a motor component, referring to facial and vocal expressions. These related components correspond to functions such as stimulus evaluation or appraisal, *monitoring* (the role of control or regulation), *preparation and support of action* and *action*.

In summary, even though the current evolved understanding of emotions suggests invaluable explanations in terms of underlying cognitive mechanisms, none is adequate to explain the immense complexity of human emotions.

2.2 Music and Emotion

From religious references such as David's healing approach for King Saul (1000 BC) to Plato's (428-348 BC) affective trials for Diatonic and Chromatic tunes (Kümmel, 1977), the emotional relation between music and humankind has often been a centre of interest. Without doubt, participating in music may arouse a wide array of affective experiences (Gabrielsson, 2011; Juslin & Laukka, 2004; Juslin & Västfjäll, 2008), and the variety of these experiences might also prompt different understandings and interpretations from individual to cultural levels (MacDonald, Kreutz, & Mitchell, 2012). Furthermore, which emotions could be expressed and induced by music has been another debate in music emotion. For example, Gabrielsson and Juslin (2003) suggested that specific basic emotion categories may be easier to express in music than others, such as *jealousy*, *eroticism* or *devotion*.

To identify the multifaceted structure of music emotions, there have been many attempts to cover elicited emotions using music. For instance, empirical mapping of the complex music emotions begun in the 1960s by Nordenstreng's (1968) research that analysed causal mechanisms through listener experiences via selected music excerpts. In the years that followed, this mapping attempt mainly specialised in excerpt-specific nature and created its own taxonomy. More recently, Gabrielsson (2002) drew attention to the difference between the emotion perceived (also known as emotion recognition or expressed emotions) and the emotion experienced (also known as induced emotions). Afterwards, almost all music emotion studies have predominantly followed this distinction. The accumulated knowledge of music emotion studies to date, and the diversity of reported findings, have driven music emotion qualities to be classified into categories such as utilitarian, epistemic and basic (Scherer, 2009). Following this, there have been many approaches to identify and cover musical emotion categories under one tool. For instance, Zentner, Grandjean, and Scherer (2008) developed a scale by validating factors that are particularly appropriate with emotion categories such as epistemic and utilitarian, known as Geneva Music Emotion Scale (Zentner et al., 2008).

In company with these described efforts, the differences between listeners, researcher approaches, and cross-cultural differences brought about other questions as well. For instance, while some listeners can describe emotions in precise terms, some of them use more broad and vague descriptions (Lindqvist & Barret,2008).

Summarised together, despite invaluable improvements in understanding music emotion studies in general, neither psychologist nor music emotion researcher has provided a full answer or mechanism for these fundamental issues that have been raised.

2.2.1 Possible Underlying Causal Mechanisms in Musically Induced Emotions

Although the previously described diversities in music emotion studies have raised the question of whether there could be a comprehensive answer to understand the underlying mechanisms in music emotions, the gathered empirical data provided substantial evidence to focus on some mechanisms that play roles in forming music emotions. The mechanisms involved in the elicitation of music emotion are ubiquitous and a product of many determinants (Scherer & Coutinho, 2013). In literature, there have been many attempts to conceptualise these causal mechanisms. For example, while Meyer (1956) connects music-induced emotions to the confirmation or violation of musical expectations, Cochrane (2010a) and Davis (1983) explained music-induced emotions through emotional contagion mechanisms. Furthermore, many researchers have also provided various frameworks, such as cue redundancy, the fractioning emotional model (Balkwill & Thompson, 1999) and the dock-in model (Fritz, 2013), by focusing on the cross-cultural differences in order to understand universality and ontogenetical processes while experiencing music emotions. The following subsections will focus on the theoretical approaches to musically induced emotions.

2.2.1.1 Multifactorial Process Model

According to Scherer and Coutinho (2013), multilevel appraisal processes act as a central mechanism of music emotions and hence should be elaborated upon comprehensively to understand the elicitation processes. As an extension of Scherer and Zentner's (2001) theoretical concept and Scherer's Component Process Model (Scherer, 2009b), the Multifactorial Process Model takes the structural factor (input variable) and the mediating factors (listener-, performance- and context-related) into account and proposes that the emotional elicitation process is a consequence of several routes. These are as follows:

Appraisal: According to the authors, the music listening process requires a continuous appraisal mechanism for subcomponents under certain groups of control whereby the relevance of group check consists of subcomponents such as novelty (also partly linked to well-known brain stem reflex mechanism), intrinsic pleasantness (e.g., a sensation of consonance or dissonance) and goal relevance. The second group of control is concerned with implications and consists of general musical expectation (outcome probability and discrepancy from expectation) and the underlying needs for music listening (conduciveness and urgency). The third group of checks is about coping potential with regards to expected consequences. Here, the authors proposed that the intentions and agents for listening to music, such as listening intention for a composer, piece or performer, might also play a role in music-induced emotions. In addition to that, the control mechanism over listening activity could play a role in this process. The final group of checks is "normative significance", whereby the listeners' social norms and personal tastes could influence the music emotions in terms of aesthetic value.

Memory Associations: This concept links the episodic and associative memory involvement in music emotion elicitation processes in which the personal experience would trigger the music emotional process due to vivid recurring of the past event (e.g., marriage).

Entrainment: This concept defines the route that is independent of appraisal, which directly influences the peripheral nervous system. Scherer and Coutinho (2013) denote rhythmic entrainment as an example of this route.

Emotional Contagion: Here, in addition to intrinsic cues, emotional reactions can be elicited by a nonauditory cue such as visual motions as well as visual observation of motor mimicry, which could result in emotional contagion.

Empathy: This concept denotes a process by observing another person's affective situation, which is important for the affected person but not necessarily for oneself. In this way, the perceiver develops an understanding attitude through empathic feelings.

2.2.1.2 BRECVEMA

As opposed to the MPM model, BRECVEMA theory alleges that music emotions cannot be explained solely by mechanisms of appraisal processes due to the irrelevance of music emotions within the context of an individual's ontogenetical realities such as culture and personal traits. By taking the brain's evolutionary processes into account, Juslin, Barradas and Eerola (2015) concluded that emotions could be triggered at multiple parts of the brain. Proceeding from this view, authors point out that music as an art form is shaped by social, political, religious, and economic context and propose that there are several induction mechanisms that developed gradually and in a particular order during evolution, from simple reflexes to complex judgments (Juslin, 2019, p. 258). Juslin (2013a) proposed that a musical event broadly consists of *music*, *listener* and *context* features. Therefore, music emotion induction process could be influenced by these features. As a starting point, he suggested the following as music induction mechanisms:

Brainstem reflex: This mechanism explains the sudden response to a powerful acoustic feature such as *sforzando.* Juslin (2019) claims that this would induce a surprising feeling and has collected evidence for that.

Rhythmic entrainment: Similar to Scherer & Coutinho's (2013) "Multifactorial Process Model", this mechanism explains the adaptation of internal body rhythm toward an externally listened-to music rhythm.

Evaluative Conditioning: A mechanism by which either a positive or negative experience with music leads to a conditioned association. Despite indicating the same concept, Scherer and Coutinho's memory association concept is a more comprehensive explanation when compared with the evaluative conditioning.

Contagion: As in Scherer and Coutinho's emotional contagion route, this mechanism explains how emotion may be experienced through mimicry. Juslin (2019) claims that the perceived voice, like an emotional expression of music, triggers this mimicry mechanism.

Visual imagery: This underlying mechanism explains a listener's inner imagination of an emotional character through metaphorical mapping of the music.

Episodic Memory: This mechanism explains a recollection of a particular memory/event from the listener's past, which is associated with a piece or a moment in a specific musical composition. The mechanism could induce any emotion but would mostly induce a feeling of nostalgia and longing.

Music Expectancy: This mechanism explains the emotional induction by violation or confirmation of syntactic structures that belong to the perceiver's music cultural traditions.

Aesthetic Judgment: A mechanism that is triggered by individuals' aesthetic values in evaluating the music they listened to. The authors stated that one might take pleasure due to confirmation of the perceiver's aesthetic values.

Although there are coincidences between these two theories, there are some fundamental differences, as well. For instance, the Component Process Model theory explains potential sub-systems that result in the emergence of an emotion at the end of production (Moors, 2014). Conversely, the BRECVEMA theory has tried to explain the specific emotional mappings for specific underlying mechanisms. For instance, the aesthetic judgment mechanism in this theory denotes a specific requirement about beauty, skill and artistic intention (Juslin & Sloboda, 2013). However, it is crucial to note that these two theories evaluate music as a general term that lacks the underlying music structures such as tetrachords, musical phrases, or unsystematic (aksak) rhythms. Furthermore, these two theories do not evaluate the values and attributions at a cultural level. The following section will discuss Musical Expectancy and related ITPRA theory, a more elaborate perspective of musical features in music emotions presented by Huron (2006).

2.3 Musical Expectancy

As can be seen from previously mentioned theories, musical expectation has occupied an important position in music, emotion and cognition. The expectancy mechanism in music attracted attention through Leonard B. Meyer and his influential book *Music and Emotion* (Meyer, 1956). Briefly, musical expectation means a listener's developed and learned mental representations are activated while listening to music. According to Meyer (1956), these musical expectancies can be observed between different musical structural parts. For example, in general, the leading tone's schematic expectation is to continue to tonic rather than another possible continuation (Narmour, 1990). This pitch continuity expectancy could also be observed in harmonic (vertical/simultaneous) and melodic (horizontal) dimensions. In a similar vein, this could be followed in rhythmic structures, too. For instance, strong beats in a rhythmic structure also give a feeling of completion (Zuckerkandl, 1956).

2.3.1 The Formation of Musical Expectancy

The expectation mechanism is a crucial mechanism due to its survival benefits (Huron & Margulis, 2010). The underlying reason for this reaction is the incentive to react faster, either to foreseen or unforeseen events (Jakobs, Wang, Grefkes, Zilles, & Eickhoff, 2009), and this general tendency is also valid for musical sequences (Bharucha & Stoeckig, 1986). However, the music expectancy mechanism strongly depends on individual learning and familiarity, which is learned first through music cultural conventions. This learning process is mostly acquired through statistical learning (known as implicit learning) (Vapnik, 1998). This exposure phase is defined as an unconscious and progressive knowledge acquisition period (Pearce, 2018) that forms the mental representation and, therefore, expectations (Huron, 2006). In terms of music mechanism, Huron and Margulis maintain that the sounds we are most exposed to become the most anticipated structures while listening to music (Huron & Margulis, 2010).

Many psychological and computational studies have confirmed the role of statistical learning. For example, Pearce and Wiggins (2006) showed that a computational model based on statistical learning could explain and predict melodic expectancy. In this model (IDyOM), a statistical algorithm learns from a music corpus and predicts future events derived from the provided music corpus.

It is believed that the acquisition of musical expectancy is a lifelong learning process. Sensitivity to consonance and dissonance has been observed in infants (Schellenberg and Trehub, 1994; Trainor et al., 2002; Virtala et al., 2013). Moreover, some empirical evidence suggests that while young children are unable to perceive the dissonances as "wrong", in later years, they learned to perceive dissonances as sounding wrong (Sloboda, 1989). Sloboda also states that more complicated tasks such as ending with a cadence could be a specific setting to a culture. The ability to perceive pitch and temporal structures is partly due to our competencies as humans but is also hugely dependent on cultural background. This process could also be generalised to refer to the process of understanding/recognising pitch and temporal structures in music. For example, while/though various motifs and the ability to perceive a pitch could be considered a universal competency, some of the music structures that depend on culture's specificity are more challenging to learn, and acquiring this kind of musical knowledge depends on later stages of development (Trainor & Hannon, 2013).

The main contradiction of statistical learning in music theory has been with the well-known paradox "Wittgenstein's puzzle". The argument is that if the musical expectation is generated from knowledge acquired through listening to music, a familiar piece should not create any violation of expectation, and therefore there should not be any affective response (Wittgenstein, 1966). In order to overcome this paradox, Dowling and Harwood (1986) suggested a hypothetical proposition for listening activity. Accordingly, the listener could only access the music processing module on a subconscious level, and therefore we create expectations continuously even though we are familiar with any piece of music. Jackendoff (1991) also described the potential existence of a musical parser that always operates regardless of the listener's familiarity with the music. Huron (2006) suggests a more comprehensive explanation based on Jamshed Bharucha's schematic and veridical modules suggestion (1987a) in order to explain this paradoxical experience. According to Huron, schematic, veridical, dynamic and conscious expectation modules operate concurrently and in parallel, allowing us to experience a surprise even when we are familiar with a musical work. For instance, even though the veridical or conscious expectation modules know what to expect, the dynamic expectation module remains active and creates a surprise effect.

In summary, music expectations fundamentally depend on the memory of listeners and their surrounding culture that is acquired by statistically learned elements. As a listener's memory is a critical concept in statistical learning and its related outcomes, the next section will discuss the relation of memory types with music expectations.

2.3.2 Memory Types in Music

The theoretical and experimental studies suggest that humans store and access memories in at least two different ways. Current literature has conceptualised these ways as Short-Term Memory (STM) and Long-Term Memory (LTM) (Snyder, 2000). LTM is defined as a more durable memory type that holds information for extended periods of time, whereas STM holds information for a relatively short period (Huron, 2006). Further distinctions have also been applied to the "Memory Concept" used by psychologists. For instance, LTM can also be broken down into two different types: "implicit" and "explicit" memory. While implicit memory refers to an unconscious memory type, explicit memory refers to a memory type that can be recalled and learned consciously. According to Rohrmeier and Rebuschat (2012), implicit (conceptual) musical knowledge is merely a product of exposure to musical structures. LTM memories are thought to be formed as a result of repeated stimulation activities (neuronal learning) that increase the connections between activated neurons (McClelland, 1995). These co-activated neurons are also called "associations" that occur on many LTM levels and can trigger other memories (Snyder, 2000). Snyder (2000) indicates that neurons' activation is a source of conceptual knowledge and autobiographical memories (see p.69).

2.3.2.1 Conceptual Categorisation and Verbal Identifiability of Musical Structures

Memory in music often is assessed by recognition tasks. Semantic and episodic memory is the primary type of memories involved in recognition. Semantic memory is also a source for conceptual knowledge categories. Conceptual categories are a bridge between memory and sensory input that results in identification and generalisation. For instance, the ability to recognise major scales requires recollection from semantic memory, resulting from conceptual categorisation. Huron (2006) claims that semantic and episodic memory is evident in listening schemas that represent current generalisations about the world of sound. According to Snyder (2000), the formation of semantic memories is not a static process in which we continue to add fine details about semantic and categoric memories. He also describes the schema commonalities, which are common to all experiences, as a meta category of all sub-semantic categories. For instance, recognition of a *major scale* is a subcategory for semantic memory processing, and syntactical expectations are also a subcategory of a *major scale*.

Compared to other domains, the investigations to understand the extent and underlying components of recognition performance in music are relatively rare and not clear. Moreover, studies in music recognition performance also showed that listeners' recognition memory in music is far below other domains (Halpern & Müllensiefen, 2008). This situation inherently raises the question of how new music becomes well learned and how melodies could be verbally identifiable.

Although there are many other contributing variables, familiarity is often referred to as the most potent variable in the verbal identifiability (also referred to as nameability) of music structures. On the other hand, listeners' sensitivity to familiarity is mostly acquired by statistical learning, which is thought to be promoted by frequency of occurrence and duration (Krumhansl, 2001). Furthermore, the studies that tested the recollection (McAuley et al., 2004) and verbal identifiability of music structures (Korenman & Peynirioglu, 2004) also suggested that these processes are mostly influenced by familiarity.

2.3.3 The Role of Musical Expectancy in Musically Induced Emotions

I have so far discussed how expectancies occur, the underlying mechanisms on the development of expectancy and its relevance with music memory. However, as mentioned earlier, the role of expectancy in music emotions is a unique subject in emotions due to its potential to merge psychological and music-theoretical explanations. Grounded in Aiken's (1950) general expectation theory of art, Meyer (1956) was the first person who linked the violation and confirmation of expectations as a source of emotion arousals. He denotes that listening to music may set up various melodic, harmonic, and rhythmic expectations, and the violations of these expectations create tensions and resolutions which induce emotions in music (Meyer, 1956). However, Meyer (1956) also points out that this process depends on the listener's creativity and style, focusing on the delayed confirmation of already structured expectations. Timmers and Loui (2019) also defined this relation as the evoked potential of tension and relaxation or stability and instability.

Many experimental studies have also confirmed the idea. For instance, in his empirical research, Sloboda's (1991) exploratory study, which focused on 'chills', showed that chills mostly occur when harmonic expectations are violated in various ways. Furthermore, the theory has also been investigated by physiological and neurological aspects. Koelsch and his colleagues (Koelsch, Fritz, Schulze, Alsop, & Schlaug, 2005), in an fMRI study, found that the violation of harmonic expectations occurs within an area of the brain that is linked to the evaluation of valence dimension in a stimulus. Subsequently, Steinbeis and his colleagues (Steinbeis, Koelsch, & Sloboda, 2006) reported that extreme violations of musical expectation correlated with higher skin conductance and induced emotions that also related to the arousal dimension. Following this, Egermann, Pearce, Wiggins, and McAdams (2013) were able to confirm a broader picture for both dimensions. As such, musical events that were statistically difficult to predict for a computational algorithm (simulating statistical learning in listeners) led to an increase of continuous arousal means, a decrease in valence means, and an increase in physiological arousal.

More recently, Juslin et al. (2015) tested participants' emotional arousal by violating their expectations through musical excerpts featuring unexpected melodic, harmonic and rhythmic sequences, which were tonally ambiguous. Results suggested a potential elicitation of anxiety as well as autonomic arousal and corrugator muscle activity.

Meyer (1956) implied that "the greater build-up of suspense, the greater the emotional release upon resolution" (p.28). Meyer also offered a qualified listener type to study affective responses to overcome the potential differences on an individual level, such as listening background. However, this also creates a contradiction for the expectancy mechanism in music because of the fact that all expectations are learnt. Huron (2006) proposed a more comprehensive approach for the relation between music expectancy and music-induced emotions.

2.3.3.1 ITPRA Theory

Huron (2006) provides many analyses that focus on musical devices' role and their relation to various mental representations by taking statistical learning and cultural background into account as well as allowing potentially brought backgrounds. He also evaluates how aesthetic distinctions are granted through musical work, genre and rendition. Accordingly, he proposes that the emotions evoked by expectation involve five functionally distinct physiological systems: imagination, tension, prediction, reaction, and appraisal. Each of these systems has the potential to evoke responses independently. The responses involve both physiological and psychological dimensions. Some of them are autonomic and might entail changes in attention, arousal, and motor movement. Others involve noticeable psychological changes such as rumination and conscious evaluation.

The explained mechanisms in ITPRA are all related to expectancy in music emotions and categorised as two pre-outcome and three post-outcome responses. Accordingly:

Imagination Response: This mechanism describes the preimagination process before participating in any musical event. Huron (2006) describes this process as a deferred gratification before achieving greater pleasure.

Tension Response: Huron defines this mechanism as preparation in arousal and attention for an expected outcome due to uncertainty. In terms of a physiological response, heart rate and blood pressure would increase, and there would also be some changes in breathing.

Prediction Response: This mechanism acts as a first experience in post-outcome. According to Huron, the accuracy of prediction, hence expectation, gives rise to a response. This response might be positive or negative depending on whether the prediction outcome is correct or incorrect.

Reaction Response: This mechanism happens simultaneously with prediction response and refers to the evaluation of the outcome as pleasantness or unpleasantness. Huron (2006) stated that the reaction response to this process is fast and followed by a somatic response.

Appraisal Response: This mechanism is also an evaluation of the outcome but differs in terms of evaluation type. As opposed to reaction response, appraisal response refers to the slower and thoughtful response to the outcome. Huron (2006) explains that this process is a more complicated process that takes into account complex social and environmental factors.

Huron (2006) defines the emotion of surprise as prototypical emotion aroused through an active expectancy mechanism. In contrast to Meyer's (1956) conceptualisation of "surprise" feeling (according to him, the surprise is most intense where special expectation is active), Huron (2006) advocates that the "surprise" feeling would be set up according to previous musical events related to both schematic and veridical expectations.

2.3.4 Music Structural Variables in Musical Expectancy

Structural variables in music have been studied through many variables, including research on tonality (Creel, 2011), melody (Cuddy & Lunney, 1995; Tillmann, Bharucha & Bigand, 2000) and rhythm (Barwick, 2002; Schultz, Stevens, Keller, & Tillmann, 2013). Since the pitch is intrinsically related to temperament systems, the next section will discuss the pitch concept within the context of expectation.

2.3.4.1 Pitch as a Source of Musically Induced Emotions in Musical Expectancy Context

Despite a lack of focus on the expectancy mechanism, the pitch dimension of musical structures has been studied in many ways in music emotion induction studies. These approaches have mostly recognised intervals, musical phrases or scales/modes as pitch-based structures. Gabrielsson (2009) concluded that while the major scale is associated with happiness and joy, the minor scale is mostly associated with sadness (cf. Hevner, 1935). Furthermore, results also showed that these major/minor scale associations are not restricted only to these two emotions (Gabrielsson, 2016). Ilie and Thompson (2011) studied the influence of register on emotion induction by manipulating selected Mozart pieces. They found that variations in register had a considerable impact on emotional experience.

In their mode study, Temperley and Tan (2013) compared the modes (Ionian, Mixolydian, Lydian, Dorian, Aeolian and Phrygian) according to their induced happiness levels. They found that Ionian (the antecedent version of major scale before 12 equal temperament major/minor tonality invention) was rated the happiest mode among other modes.

Previous reports (cf. Gerardi & Gerken, 1995) have found that melodic contour does not have any effect on emotional expression. However, Gabrielsson and Lindström (2010) provided evidence that while ascending melody may be associated with tension, happiness and dignity, the descending melody may be associated with emotions such as vigour and sadness.

More recently, Sauve, Sayed, Dean, and Pearce (2018) conducted a study to understand the effects of pitch and timing expectancy on musical emotion. The study involved 20 musicians and 20 nonmusicians. It was observed that pitch and temporal musical structure have an effect on listeners' expectancies and emotional reactions, which can also be manipulated. In addition, they concluded that temporal expectancies influence perception contrary to pitch expectancies. This discrepancy can be interpreted as a consequence of individual differences.

2.3.4.2 The Role of Musical Expectancy on Verbal Identification of Musical Structures

The memory concept and its direct relation to musical expectations have grabbed intense interest by researchers. Even though there are some other distinctions in musical expectation types (cf., Huron, 2006), Bharucha's (1987a, 1994) distinction between schematic expectation and veridical expectation serves as a foundational starting point in memory and expectation relation. While schematic expectations define the overall knowledge and conventions that we learn consciously or unconsciously, veridical expectations define the expectations that we formed while listening to music and based on that music. For instance, Justus and Bharucha (2001) tested the influence of veridical expectation on harmony, priming by presenting the previews of prime target pairs or setting local transition probabilities favouring harmonically less related pairs. According to the results, despite the presence of valid veridical expectations, the schematic expectations were comparatively more effective. Other studies have also confirmed the overall superiority/success of schematic expectations. Tillmann and Bigand

(2010) studied the veridical expectation by familiarising two groups of participants with different sets of chord sequences. In the exposition phase, while one group of participants performed a timbre identification with a tonic ending, the other group performed the same task but with a subdominant ending. In the testing phase, all groups performed all sequences. According to the results, despite having shorter reactions to the related chord sequences, schematic expectations were not affected by this familiarisation period. Various EEG studies have also confirmed these findings on music syntactic processing (cf. Guo & Koelsch, 2016). As is the case with the interdependent nature of STM and LTM, the schematic and veridical expectations are interdependent in the event of listening (Guo & Koelsch, 2015). Justus and Bharucha (2001) state that, although the two mechanisms progress in a parallel way, the process becomes divergent due to the exposure phase. Tilmann and Bigand (2010) indicate that these two mechanisms are resistant to each other, and Justus and Bharucha (2001) denote that schematic expectations are processed much faster than veridical expectations, despite a listener's recent exposure to an unexpected piece of musical material.

It has commonly been assumed that the recognition memory for tunes and the verbal identification of these tunes are strictly influenced by familiarity. For instance, McAuley et al. (2004) compared the recognition performance of novel and well-known melodies through how recently and frequently melodies were studied. Results showed that the recognition performance in well-known melodies was significantly higher than in novel melodies, and the frequency of occurrence has also influenced the recognition performance well above chance. Moreover, the authors tested the verbal identification of tunes based on a naming test administered to each participant at the end of the experimental session. Results suggested a reliable correlation (r = .52) between well-known tunes and their verbal identification performance. In a similar vein, Korenman and Peynircioglu (2004) tested the melodic recall performance by pairing animal names with selected novel and well-known melodies. The correct recall performance was substantially higher for well-known melodies suggesting that the verbal identification of tunes is influenced by familiarity.

2.4 Temperament Systems

Temperament system is an approach to pitch and octave division, and it varies in music-making from culture to culture. Temperament systems can be used to define the pitch-related processes of appropriation, interpretation and understanding of meaning in music. This proposition is based on statistical learning in music. Accordingly, if the most exposed sound is the most expected one, then temperament systems might have a place in music expectations and also be a cognitive resource for all pitch relations as it acts as an ecosystem of all pitch-related structures. Therefore, temperament systems could be qualified as a vital and crucial source for the continuously recurring sonic environment.

As mentioned before (see Section 1.1), the distinction between 'tuning' systems and 'temperament' systems lies in the historical differentiation between pure and tempered intervals (Rasch,1983). This distinction is due to the well-known closure problems in "Pythagorean Tuning Systems". Accordingly, in terms of mathematical representation, there is no way to obtain a closed system in Pythagorean Tuning System due to the desire to have pure intervals and transposition capabilities together. For instance, if we go up seven octaves from a low C pitch by taking the octave ratio (2/1), we will end up on the no. 128, which is the seventh power of 2 (2^7). Subsequently, if we use the 3/2 ratio to obtain C pitch which is seven octaves above, we will end up on 129.74632. The cent difference between these derivation approaches is also known as the Pythagorean comma. The first examples of temperament systems are fundamentally focused on diffusing this difference across fifths to obtain the so-called best perceptible pure version. Therefore, musical systems that do not depend on pure intervals or simple ratios are known as temperament systems (Barbour, 2004). Despitepractical discussions that date back to the seventeeth century, the conceptualisation of temperament systems seems to have begun in the 1400s (Riemann, 1898).

Music theoretical and historical practices have shown that in literature, temperament systems are separated into two different categories: regular and irregular temperament types. While regular temperament means a temperament system that uses the same size fifths, the 'irregular' temperament systems use fifths that differ in terms of size. The most common regular temperament is the 12 tone equal temperament system (hereafter ET). In literature, there is a distinction between equal and unequal classifications. An equal division of interval refers to the usage of all pitches within a whole step. Unequal division means that the usage of the produced pitches within a whole step could change according to used subcategories such as scale or a tetrachord.

2.4.1 How Do the Temperament Systems Differ Between Cultures?

The particular temperament system adopted by a musical culture can be evaluated through biological constraints and cultural practices. Cariani (2019) denotes that even though these two kinds of source seem different, they are complementary. Although the biological constraints (i.e., auditory system) provide crucial information on how these cultural selections were adopted, the hedonic/pleasantness end of these selections is often more dominant and depends on the cultural convention which coevolved with timbral structures.

Temperament systems often show differences in the whole tone division (9/8 ratio). For example, the Indian Shruti 22 note system dominantly uses 22 divided pitches in an octave and in this approach, one whole step is formed by five unequally divided pitches (from a ratio of 1:1 to 9:8). It is noteworthy that the whole tone's division does not only produce additional pitches but also affects the placement of pitch position in the pitch continuum. For instance, the 19 ET temperament system divides a semitone into 19 equal pitches with a 63.16 cents value. As a result, the distance between 1:1 to 9:8 comprises 189 cents value which creates perceptible sensory differences from other whole tone divisions.

On the other hand, these pitch-related differences in temperament systems' formation approach might also cause transposition problems. For instance, 'just' intonation is the tuning system that only calls for pure intervals. However, this also causes modulation (transposition) problems across keys for any composed harmonic or melodic construction. The invention of the 12 equal temperament system is a crucial example of solving these modulation problems.

2.4.2 12 Equal Temperament System

The 12 ET system is one of the most used temperament systems not just in Western societies but also across the globe. The main reason for the widespread use of the 12 ET system is the simple solution that it gives to modulation problems. Put simply, the 12 equal temperament system is a division approach that divides the octave into 12 equal parts by 100 cents value. In the 12 ET system, a whole tone is formed with 200 cents and has only one accidental (enharmonic) that divides a whole tone. Another significant difference of the 12 ET system is the involuntary limitation to the major and minor tonality. According to Duffin (2007), although this simple and effective solution opened a new way for harmony, it also caused a lost sense of other scale/heptatonic constructions and hence sensory awareness for the different scales/modes. The 12 ET system's current form has been shaped after much-refined calculation (Jorgensen, 1991) and was not in use in pianofortes until 1885 (Duffin, 2007). Jorgensen (2009) emphasises that all early formations of ET should be regarded as *quasi* equal approximations because the knowledge of a correct tuning method did not exist before 1887, and the correct mathematical solution, as we know it today, was not perfected until 1917. Various well-tempered systems such as *Werckmeister* were also widely used until the end of the nineteenth century, and many of the early ET systems were possibly mixtures of equal and well-tempered intervals (Duffin, 2007).

2.4.3 Perceptual and Cognitive Foundations of Temperament Systems

The perceptual dimension of temperament systems should be evaluated comprehensively due to its role as a fundamental basis for all pitch-based relations. This section is going to discuss some temperament-related blocks in a gradual way to cover the temperament concept as much as possible.

2.4.3.1 Pitch

The perception of the pitch has been discussed in literature through its physical correlates and its psychological correlates. While the physical correlates dimension focused on factors such as the perceptible limits (Oxenham, Micheyl, Keebler, Loper, & Santurette, 2011), the discrimination abilities of pure and complex tones (Micheyl, Delhommeau, Perrot, & Oxenham, 2006; Moore, 1973), roughness (Kameoka & Kuriyagawa, 1969; Plomp & Levelt, 1965) and harmonicity (McDermott et al., 2010), the psychological correlates are evaluated through grouping principles of melodies (Russo, Thompson, & Cuddy, 2015), melodic organisation and how they influence pitch expectations (Narmour, 1990; Krumhansl, 1995; Schellenberg, 1996) and context-dependent schemas (Krumhansl, 1990; Krumhansl & Kessler, 1982; Leman, 2000). To explain the perceptual process in the experience of pitch, there have been two main theories known as "place" and "temporal" coding theories (Oxenham, 2013; Sethares, 2005). The main difference between these two theories lies in the definition of the process and its neurophysiological basis. For instance, while "place" coding theory emphasises the importance of frequency content which could result in stimulation of the basilar membrane, leading to stimulation of different groups of inner hair cells, associated to different critical bands (Von Helmholtz, 1895/1912), "temporal" coding theory stresses a constant temporal analysis and evaluation of periodicity for determining the frequency content in the musical pitch hearing experience. The more recent addition to pitch perception theories is a merged approach of previously mentioned theories: place time theory. According to De Cheveigné and Pressnitzer (2006), the auditory filters' impulse response time that depends on the central frequency is postulated to determine the range of periodicities. There is also a growing research body (Cedolin & Delguette, 2010; Shamma & Klein, 2000), supporting suggestions of place time theory (Graves & Oxenham, 2019). Along with the desire to explain the musical pitch hearing phenomenon, there is also another important factor called *critical bands* (Rossing, Moore, & Wheeler, 2002). Critical bands refer to fine frequency perception. This ability is generally assessed with the *Difference Limen* (also known as *Just Noticeable Difference*) parameter. The investigation of *Difference Limen* has shown that the ability to distinguish pitches can vary from three cents (Micheyl et al., 2006) to 30 cents (Heller, 2013) depending on individual differences. Furthermore, much research also showed that musicians have a lower threshold compared to nonmusicians (Micheyl et al., 2006; Vexler & Zaltz, 2001).

To label a pitch with all dimensions (height and chroma) has been rare among people (Takeuchi & Hulse, 1993). Previous studies suggested that listeners without absolute-pitch (AP) could store some melodies by preserving the only intervallic identity of melody. On the other hand, recent evidence suggests that listeners can also store absolute pitch representations in long-term memory (Bergeson & Trehub, 2002; Halpern, 1989; Levitin, 1994; Schellenberg & Trehub, 2003).

In general, statistical learning in music explains the consolidation of pitch memory as a process that is based on exposure to the music cultural features. Accordingly, this process starts with an unconscious acquisition period and subsequently becomes a conscious process (Huron, 2006). This theory has also been tested by many studies that span from Western tonal music's intrakey and interkey relations (Krumhansl, 1990) to cross-cultural research (Castellano, Bharucha, & Krumhansl, 1984; Curtis & Bharucha, 2009; Eerola, Louhivuori, Lebaka, 2009; Kessler, Hansen & Shepard, 1984; Krumhansl et al., 2000; Krumhansl, Louhivuori, Toiviainen, Jarvinen & Eerola, 1999) which confirmed that listeners are often sensitive to their own cultural music features as a result of statistic learning in music (Huron, 2006).

2.4.3.2 Sensory Dissonance and its Subjective and Cultural Dimensions

Since the nineteenth century, many theoretical and experimental approaches have investigated what musicians and listeners call dissonance and its opposite consonance. The basic attempts to explain sensory dissonance/consonance foundations comes under three overall interpretations: (i) the Pythagorean approach that suggests the positive relation between the simplicity of small integer ratios; (ii) the harmonicity approach that suggests the absence of interference between harmonic spectra, which is known as physicalism (Schneider, 2018); and (iii) the biological approach that denotes the recognition of human vocalisation as a cause for sensory dissonance (Bowling & Purves, 2015). Among these attempts, Von Helmholtz's (1895) theory of consonance and dissonance has been one of the most influential theories in many pitch perception studies. According to his theory, the more deviation from a fundamental frequency's higher partials (harmonics), the more disturbances in sensation, referred to as roughness. Roughness is also known as beating, and some experimental evidence also suggests a negative correlation between roughness and liking/pleasantness, at least in Western participants (e.g., McDermott et al., 2010; Stolzenburg, 2015; Terhardt, 1974; Ushakov, Dubkov, & Spagnolo, 2010;). Indeed, the predominant understanding of the harmonic partials through physics dates back to Sauveur's (1701) harmonics investigation in vibrating strings. Fundamentally, the willingness of seeking 'natural rationale' in physics and Zarlino's approach on the division of fifths (an early basis for major and minor dualism) could be a basis for this widespread understanding (Schneider, 2018). Moreover, the invention of polyphonic music and the historical place of Just Intonation in Western music culture have also contributed to the widespread understanding, too. Therefore, from Rameau (1737) to Riemann (1873) and from

Helmholtz (1870) to Terhardt (1984), the explanation for sensory dissonance is actually a coevolved understanding of Western polyphonic music and its physical explanations. In this direction, studies that investigate the harmonic spectra absence have also claimed the universality of sensory dissonance through harmonic partials. For instance, Zentner and Kagan (1996) reported that consonance and dissonance based on harmonic partials (through comparing ET intervals) is a concept that is likely to be universal in music. On the other hand, much earlier studies also contradicted this generalisation. For instance, Kaestner (1909) played different intervals to German listeners and asked them to evaluate presented intervals' consonance level. According to the results, a tritone interval was rated almost as consonant as the octaves, and major thirds and perfect fifths were more consonant than perfect unison and perfect octaves, which are historically referred to as the most consonant intervals.

More recently, a seminal study by McDermott and his colleagues (McDermott et al., 2016) reported that consonance/dissonance itself varies between cultures, which suggests that the concept cannot simply be explained by mere reference to physical properties. Several theories attempted to explain the role of culture in sensory dissonance and showed that while listeners might gain implicit knowledge through mere exposure (Zajonc, 2001), they might also induce aesthetic responses through classical conditioning (Olsen, Thompson, & Giblin, 2018). Given these results' suggestions, sensory dissonance perception necessitates a multiperspective that includes the role of learning and expectation (Arthurs, Beeston, & Timmers, 2018; Rohrmeier & Rebuschat, 2012; Parncutt, 2006; Parncutt & Hair, 2011).

2.4.3.3 Intervals

Listeners can mostly identify and categorically recognise different musical intervals, either in melodic shape (sequentially) or harmonic shape (simultaneously). Several perceptual experiments in the categorical perception of intervals (Burns, 1999; Howard, Rosen, & Broad, 1992; Thompson, 2013; Zatorre & Halpern, 1979) suggest that musical interval perception is a good example of categorical perception. Also, some studies showed that the tonal context also has an effect on interval perception, which is mostly influenced by familiarity (Graves & Oxenham, 2017; Umemoto, 1990). As mentioned previously, the prevalent understanding of physicalism has also influenced interval perception studies. For instance, Vos (1986) reported that listeners could distinguish two cents deviation from a simple ratio. However, it is essential to consider that the studies that supported a simple ratio idea are mostly compared to the ET intervals with just intonation, an antecedent of the 12-ET system, and could also be qualified as a psycho-cultural entity of Western culture. On the other hand, scholars also emphasise that although inharmonicity could help to discern intervals, cultural conditioning and individually learned musical skills are essential and crucial in the intervals' perception and cognition (Arthurs & Timmers, 2013; Stevens, 2004).

More recently, Parncutt and Hair (2018) criticised the Pythagorean ratio approach for the definition of intervals. Parncutt and Hair argued that modern studies of performance intonation and interval perception show no consistent preferences for specific ratios, and no known brain mechanism is sensitive to ratios in musical contexts. Moreover, he and his colleague emphasised that although intervals and scales depend on certain acoustic factors, they are primarily psycho-cultural entities. Therefore, Parncutt and Hair suggest that the Pythagorean ratio (actually all mathematically based representations) should fundamentally be rejected due to a lack of evidence, and the cultural aspects of pitch and its blocks should instead be taken into consideration.

To summarise, the sense of a piece being 'in tune' (intonation) and perception is partly determined by acoustical features but mostly by cultural conditioning and individual capabilities alongside (personal) musical expertise.

2.4.4 Research on Temperament Systems in Music

Temperament systems have received limited attention in the music psychology field. The first body of research had mostly investigated performers' or listeners' intonation accuracy (Kopiez, 2003; Warren & Curtis, 2015). For instance, Kopiez (2003) tested temperament systems by observing instrument players' adaptability to different presented temperament systems. He compared a different temperament and tuning system (equal temperament and just intonation) by presenting five interval categories within an embedded melody task. Results suggested that players could not adapt to the unfamiliar temperament (just intonation), and the deviation of intonation from the familiar temperament system was much less when compared with the unfamiliar temperament system.

Another body of research investigated the preference of tuning systems (Geringer, Macleod, & Ellis, 2014; Loosen, 1995). Loosen (1995) studied the preferred tuning systems by musicians and nonmusicians. He compared three different temperament systems (Pythagorean, 12 equal-tempered and just intonation) through a computer-generated diatonic C major scale. Accordingly, temperament system preferences (participants' preferred familiar temperament systems) differentiated in accordance with participants' instrument and nonmusicians showed no significant preference differences. In a similar vein, Hahn and Vitouch (2002) studied perceived preferences of four different tuning systems (just intonation, Pythagorean tuning, meantone temperament and equal temperament) in a forced-choice experiment. They used realistic musical stimuli that included chord sequences and musical excerpts from real compositions with varying instrument timbres (piano, organ, choir). Responses from three participant groups (pianists, string players and nonmusicians) were overall quite mixed. Results were interpreted by authors as lacking consistency and strong significances as the preferences varied, not only between participant groups but also between stimuli types and between instrument timbres. Despite observing a "familiarisation effect" suggested by Loosen (1994, 1995) in a few trials, the results suggested that preferences were unpredictable and depended on the stimuli. The study's main conclusion was that "tuning preferences in a real musical context are moderated by musical expertise, familiarity, timbre, and musical content of the piece."

In their study, Rakowski and Miśkiewicz (1985) tested all the possible interval relations in a 12 interval equal temperament system through a comparative approach via a reproducing method. They found an interquartile deviation between 20 and 45 cents and participants exhibited precision while reproducing small intervals. To understand these intervals' mental representations in memory, Rakowski (1990) also tested 12 equal temperament system's intervals via a set of experiments. He tested all possible intervals again with or without musical context in his study, either by letting participants adjust their preferred intervals or select via systematically created intervals. He found that small intervals could be remembered and tuned much better for a free tuning task than larger intervals. The same behavioural trend was also observed during a categorical identification task.

The studies that directly or indirectly investigated temperament systems either used well-known songs (Levitin, 1994; Schellenberg & Trehub, 2003) or focused on the detection of mistuning (Trehub, Schellenberg, & Kamenetsky, 1999), which might also be a result of overexposure or a timbre effect (Warrier & Zatorre, 2002). Moreover, in pitch discrimination tasks, whether the ability of discrimination is a consequence of tonal context (Butler, 1989; Tillmann & Marmel, 2013) or harmonic beats of the interval (McDermott et al., 2010; Parncutt, 1989) has also been a debate point, and the answer is still unclear due to differences between experimental paradigms.

On the other hand, many studies also investigated the rapid acquisition of a temperament system (referred to either as a musical system or as music scales) through statistical learning in music theory. Loui, Wessel, and Hudson Kam (2010) tested the learning performance by exposing participants to various melodies derived from an artificial temperament system (Bohlen-Pierce). Their results suggested that after increased exposure to melodies, participants' recognition performance to the new system's acoustic features significantly increased, indicated by probe tone means. Furthermore, the preference means also showed that the new system was more preferable to other system. They also reported that this preference and generalisation were not influenced by prior knowledge of music. Leung and Dean (2018a; 2018b) tested an artificial microtonal temperament acquisition process in a more recent study. As in Loui et al.'s (2010) study, they reported that rapid learning of temperament systems (referred to as pitch intervals) is possible and better in a familiar melodic context. Even though both studies suggest a quick adaptation of listener mental representation, these studies did not compare familiar and unfamiliar temperament systems as an experimental comparison in order to understand the role of temperament systems in long-term memory.

Even though these results suggest the relevance of learning and familiarity in the experience of temperament systems, the effect of temperament systems on emotion induction and verbal identification performance has received very limited attention.

The next section will discuss the Turkish makam music and its related structures.

2.5 Turkish Makam Music

Although there are many debates about whether Turkish music is a mixture of various traditions, it has unquestionably a long music history that may have been influenced by surrounding cultures and geography. Turkish makam music is a member of the Makam tradition (also known as *Maqam*) spanning a geographic area including Western Asia, North Africa and Southern Central Asia (Feldman, 1996). At present, Makam Music in Turkey is mostly performed by ensembles featuring main instruments such as oud, tanbur (instruments with a plectrum), kanun, santur (zithers), kemençe, rebab, violin (bowed strings), ney, clarinet (woodwinds), kudüm, bendir, daire, def, and darbuka (percussion). As well as featuring many stylistic and genre differences, Turkish makam music has separated into two main branches. The first one of these branches is *Turkish Art Music,* which is also known as Ottoman palace music (Signell, 1986). The other one is *Turkish Folk Music,* which might also be qualified as more rural Turkish music.

Nevertheless, the two branches share the same music historical and musical structures. Apart from having a strong oral tradition, Turkish music also has its systemised music evolution. Although some historical signs indicate that Turkish Makam music dates back to the 1300s, some ethnomusicologists (cf. Feldman, 1996) emphasised that the genuine musical culture was created roughly between 1550 and 1750 (see p.20). Despite having its own notation (cf., Hampartszum Notation and Abjad) and its extensive usage in musical life, at the beginning of the eighteenth century, Western notation became more common in Ottoman music life.

The music theoretical foundations of Turkish makam music have often been a subject of debate. For instance, despite having strong theorists and performers such as Cantemir, Ismail Dede Efendi and Limonciyan, the standardisation of Turkish makam music's temperament system was developed just after the Turkish Republican Revolution (1923). Following the Republican Revolution, there came a strong distinction between the music played at formal and informal occasions as the ruling ideology aimed to merge the tradition with European techniques. As a consequence of this ideology, for instance, two types of state conservatoires in Turkey still strictly distinguish themselves as either traditionalist or Westernised. While Turkish Music State Conservatories have a Makam and a 24 unequally divided temperament-based curriculum, State Conservatories have the Western tonal music and a 12 equally divided temperament-based curriculum.

2.5.1 Musical Structures in Turkish Makam Music

This section will briefly explain the musical structures of Turkish makam music. To allow for more understanding throughout the thesis, the information presented is going to be compared with the equivalent 12 ET system components.

2.5.1.1 24 Unequal Interval Temperament System (Arel-Ezgi-Uzdilek)

Although there are many debates on whether the 24 unequal temperament system (OT, original temperament) can represent all features of Turkish makam music (like in Western music traditionalists), the 24 UE temperament system is currently the standard for Turkish makam music. Furthermore, this standardisation has also been applied to instrument manufacturing and renotation of traditional repertoire according to the 24 UE temperament system.

In Turkish makam music, in comparison to the Western equal temperament (ET) system, an octave includes 24 different pitches, and a whole step is divided into nine equal steps (with the Holdrian Comma) and a half step is divided into four equal steps. Each of these steps is called a comma – the Turkish makam music system's smallest interval unit. In contrast with common usage of solmization, every pitch in a 24 unequally divided temperament system has different names, and these names also differ when repeated in the upper octave.

As shown in Figure 2.1, the original temperament (OT) system (known as Arel-Ezgi-Uzdilek) uses unequal intervals, meaning that the notes used are not divided equally within the octave. This means that not all nine commas that exist in the whole step are used.

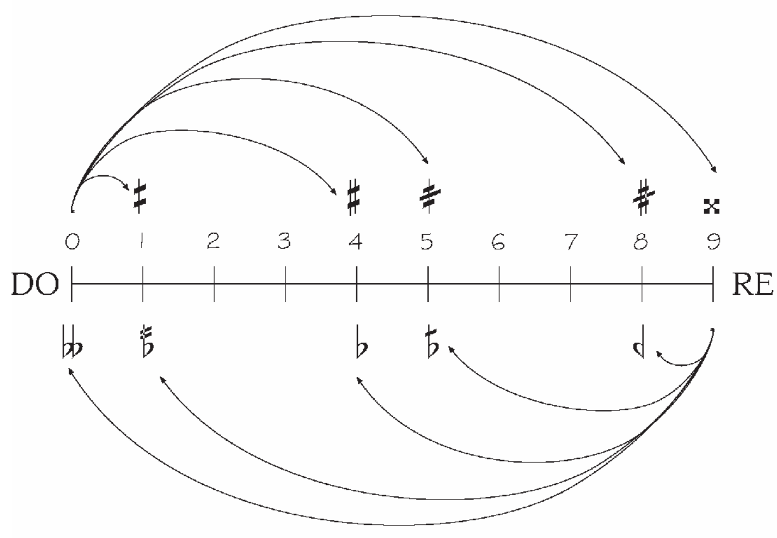


Figure 2.1. Arel-Ezgi-Uzdilek division of a 9/8 whole tone into nine commas

Table 2.1

The Division of Fa-Sol (9/8 ratio/whole tone) in AEU and 12 ET

	AEU Ratios		Notation	ET Ratios
0:	4/3	F	G𝄫	4/3
1:	177147/131072	F𝄲	G𝄭	
2:				
3:				$2^{1/12} = \sqrt[12]{2}$
4:	1024/729	F♯	G♭	
5:	729/512	F𝄰	G𝄭	
6:				
7:				
8:	262144/177147	F𝄰	G𝄳	
9:	3/2	F𝄪	G	3/2

Abbreviations: ET equal temperament; AEU Arel-Ezgi-Uzdilek.

Another important difference between OT and ET is the concert pitch. As shown in Figure 2.2, in Western music (ET), while the frequency of 440 Hz is referenced as A pitch, in Turkish makam music, this frequency is referenced as D note. This means that a Western-trained musician hears the notes are fourth lower than those that appear on the staff.

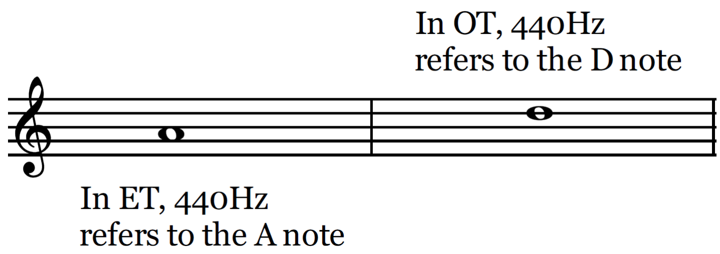


Figure 2.2 The concert pitch references in Western and Turkish makam music

Table 2.2

The 24 Unequal Interval System Pitches with Frequency Ratios and Cents (Yarman, 2008)

Pitch	Frequency Ratios	Cents	International Interval Names	Pitch Names in Turkish
0:	1/1	0.000	Unison	*Hypo çârgâh*
1:	256/243	90.225	Limma, Pythagorean minor 2nd	*Hypo nîm hicâz*
2:	2187/2048	113.685	Apotome	*Hypo hicâz*
3:	65536/59049	180.450	Pythagorean diminished 3rd	*Hypo dik hicâz*
4:	9/8	203.910	Major whole tone	*Yegâh*
5:	32/27	294.135	Pythagorean minor 3rd	*Hypo nîm hisâr*
6:	19683/16384	317.595	Pythagorean augmented 2nd	*Hypo hisâr*
7:	8192/6561	384.360	Pythagorean diminished 4th	*Hypo dik hisâr*
8:	81/64	407.820	Pythagorean major 3rd	*Hüseynî aşîrân*
9:	4/3	498.045	Perfect 4th	*Acem aşîrân*
10:	177147/131072	521.505	Pythagorean augmented 3rd	*Acem aşîrân*
11:	1024/729	588.270	Pythagorean diminished 5th	*Irak*
12:	729/512	611.730	Pythagorean tritone	*Geveşt*
13:	262144/177147	678.495	Pythagorean diminished 6th	*Treble geveşt*
14:	3/2	701.955	Perfect 5th	*Râst*
15:	128/81	792.180	Pythagorean minor 6th	*Nîm Zirgûle*
16:	6561/4096	815.640	Pythagorean augmented 5th	*Zirgûle*
17:	32768/19683	882.405	Pythagorean diminished 7th	*Treble Zirgûle*
18:	27/16	905.865	Pythagorean major 6th	*Dügâh*
19:	16/9	996.090	Pythagorean minor 7th	*Kürdî*
20:	59049/32768	1019.550	Pythagorean augmented 6th	*Treble Kürdî*
21:	4096/2187	1086.315	Pythagorean diminished 8th	*Segâh*
22:	243/128	1109.775	Pythagorean major 7th	*Bûselik*
23:	1048576/531441	1176.540	Pythagorean diminished 9th	*Treble Bûselik*
24:	2/1	1200.000	Octave	*Çârgâh*

2.5.1.2 Musical Intervals

When compared with Western music intervals, Turkish makam music has a different categorical definition of intervals as a result of its whole tone division. Furthermore, categorisation of the intervals according to tonic distance (i.e., major 7) is also completely different when compared with the 12 ET system (Özkan, 2000). Even though there is categorisation of intervals, comma calculations between the two pitches are more common practice. The main reason behind this approach is also strictly related to the whole tone division and its unequal usage. The used intervals in Turkish makam music as follows:

Table 2.3

The Original Turkish Temperament System Interval Names

Interval names	Letter signs of intervals	Cent values of intervals	International interval names	Pythagorean commas	Holdrian commas
Fazla	F	23.46		1.00	1.04
Bakiye	B	90.22	*Limma*	3.85	3.99
Kucuk Mucennep	S	113.69	*Apotom*	4.85	5.02
Buyuk Mucennep	K	180.45	*Pythagorean Diminished 3rd*	7.69	7.97
Tanini	T	203.91	*Major 2nd*	8.69	9.01

2.5.1.3 Genus (Cins)

A genus is the basic building block of Turkish music which inherited by Ancient Greek music theory (Marcus, 2015a). As shown in Figure 2.3, Turkish makam music often uses the trichords as a genus (a pitch set that includes three notes and two interval units) and tetrachords and pentachords to produce much broader tonal-spatial representations. For instance, in Western music, a scale is produced by adding a new tetrachord above another tetrachord. However, in Turkish makam music, these relations are based on the combinations of trichords, tetrachords and pentachords, and those chords are given names for their 'flavour' (also known as *çeşni* in Turkish) or melodic character on the note where they move melodically. Despite there being almost a hundred different genera documented, there are 20 commonly used genera in Turkish music. From a performer perspective, each genus advocates a fundamental fragment, and these fragments have very distinct and recognisable features and a basis to build longer melodies. Throughout the thesis, I will refer to all genus constituents such as trichords, tetrachords or pentachord as a genus.

Huzzam Pentachord in ET

Huzzam Pentachord in OT

Figure 2.3 Huzzam Genus (pentachord) example in the Original Temperament and Equal Temperament.

Note: Although corresponding to the same tonic pitch frequency as equal temperament (ET), the original temperament (OT) version of the Huzzam Tetrachord has been shown as an F sharp in G clef due to traditional notation and diapason differences between ET and OT.

2.5.1.4 Makam

Oransay (1966) notes that "'*Makam*' literally means 'place, spot, state'. As a technical term of music, the word was derived from the 'seat' of the melody, i.e., from the single tone upon which the melody rests, or sometimes the final tone or the melodic dominant" (Oransay, 1966, p. 71). A makam is a melodic texture (tessitura) consisting of progressions, directionality, tonal and temporary centres and cadences from a musical standpoint. For instance, although *Neva* and *Tahir* makams contain identical notes in their heptatonic representations, they have different names due to their differences in directionality (while *Neva* is ascending, *Tahir* makam is descending). Makam can also be compared with the concept of a scale. However, from a perceptual perspective, in addition to providing the sense of tonic and dominant (Bozkurt, 2008; Yarman & Karaosmanoglu, 2014), makams contain defined melodic patterns that aid the recognition of their emotional expressivity and identity. Despite some objections, makams have been categorised according to their starting scale degree. For instance, Cantemir (d.1700) distinguished between makams using basic scale degrees and those using secondary scale degrees. Furthermore, within the first category, he separated the makams of the "lower notes/soft notes" from those of the "upper notes/sharp notes".

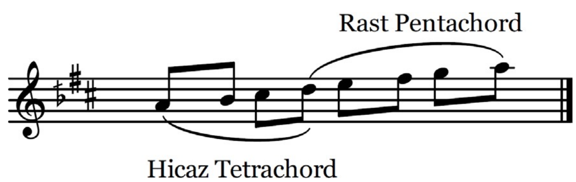


Figure 2.4 Hicaz makam example

In Turkish makam music, makams are divided into three categories as basic makams, transposed makams and compound makams. Basic makams are the genera which played within their defined pitches. On the other hand, transposed makams represent the makams that transpose from their historically defined pitches. Compound makams represent the makams that start with different makams but conclude with different makams to create a new flavour. For example, once the *Acem* makam is concluded with the *Kurdi* flavour, it becomes an *Acem-i Kurdi* makam that has distinguishably different audible characters from both makams.

3. General Aims of the Thesis

Based on the literature discussed in the previous chapters, the following conclusions for the investigation of temperament systems on emotion induction and verbal identification performance can be drawn:

3.1 Implications for Research on the Effect of Temperament Systems on Music Induced Emotion and Verbal Identification of Makams

The pitch-based cues in musically induced emotions and verbal identification of musical structures have been intensively investigated in the current academic literature. However, despite representing the foundation of pitches and intervals for all hierarchically organised music (Meyer, 1973), the effect of temperament systems has received very limited attention either by itself or on a cross-cultural perspective on emotion induction and verbal identifiability of music scales. The relation between temperament systems and emotion induction have been evaluated under statistical learning in music theory (Huron, 2006). We know that the theory of statistical learning predicts that listeners acquire knowledge about statistical regularities in music through passive exposure through them. Based on this knowledge, listeners form expectations that can be violated or confirmed in listening to music. Furthermore, previous research has shown that these moments of expectation violations are linked to emotional responses to music. I believe that I can expand the theory of statistical learning in music also to temperament systems. Moreover, by looking at verbal identification performance, I aimed to understand whether semantic memory thus the conceptual categorisation of musical structures is influenced by temperament systems. Moreover, to study verbal identification performance, in addition to understanding the underlying musical structures that form semantic memories, will give new perspectives, too, that can practically be used from a music teaching perspective.

In the pre-experiment, I predict that unfamiliar temperament system (OT) should lead to different emotional responses compared to a familiar temperament system (ET) due to a lack of previous exposure to them. Furthermore, based on previous research suggestions (cf. Loui, Wessel, & Kam 2010; Leung & Dean, 2018), I hypothesise that listeners' responses change through exposure to the temperament systems in the ear training course.

Along with the study's exploratory nature, another aspect of my consideration is to see whether cultural background might affect this experience even if the listener is formally educated under the ET system. In doing so, in addition to exploring the temperament experience through a statistical learning context, I also wanted to see whether the surrounding eco-cultural sonic environment (Clarke, 2005; Feld 2006; Impey, 2006; Impey, 2013) would affect the emotional experience and verbal identification performance.

3.2 Methodological Design Criteria

The methodological implications of the thesis are based on two different criteria. The first criteria can be categorised under the music emotion measurement subject. Accordingly, I concentrated on more general categories such as basic or aesthetic emotions instead of focusing on a specific stimuli-intended emotion relation. To do this, I reduced the GEMS-25 (Zentner et al., 2008) questionnaire to the three underlying second-order factors: Sublimity (combining wonder, transcendence, tenderness, nostalgia, peacefulness), Vitality (combining power and joyful activation), and Unease (tension and sadness) by producing a mean score for each second-order factor. In this way, I also had a chance to cover music-emotion categories generally. In addition to that, to distinguish felt and perceived emotions (Gabrielsson, 2002) in all experiments, participants were strictly and explicitly instructed to rate only induced emotion on every stimulus listening.

The second criteria can be categorised under the *habituation* subject. Previous habituation research and pitch training were mostly realised through exposure to target an auditory stimulus. Here, those approaches use either a single tone or an artificial scale (Loui et al., 2010) or short melody singing tasks (Zarate, Delhommeau, Wood, & Zatorre, 2010). In this thesis, the habituation phase is based on the ear training concept. Here, instead of being exposed to the target stimulus, participants have been exposed to the more makam-specific auditory materials that help generalise the categorisation of makam. Furthermore, in comparison to other approaches, participants have also participated in gradual solfeggio reading, music-theoretical and music-historical instructions in addition to singing tasks. Therefore, ear training might be specified as an approach which aims to simplify auditory generalisation of the target subsystem such as scale or makam through presenting all possible pitch relations.

3.3 Aims of the Experiments

Following these mentioned implications, the three experiments presented in this thesis have the following focuses:

Experiment 1: Temperament systems have been tested neither in an emotion and verbal identification context nor within methods mentioned in previous sections. Thus, to test the hypothesis and the viability of the proposed methods, a preliminary experiment was carried out in the UK. The research questions regarding this experiment were whether participants' emotional responses differ according to presented temperament systems and whether familiarity could play a role in emotional responses to Turkish makam music and its verbal identification performance. Every participant was asked the name of the listened-to makams at the end of every listening session in order to understand the effect of temperament systems on the verbal identification performance of makams. Another important aim of this experiment was to understand the applicability of the proposed methods in this thesis.

Experiment 2: This study was methodologically identical to Experiment 1. However, Experiment 2 mainly differentiated from Experiment 1 by the length of the ear training course, selected makams and cross-cultural aspects by including Turkish participants who were educated under the ET curriculum.

Experiment 3: The results of Experiments 1 and 2 indicated a potential existence of veridical expectations while experiencing temperament systems. In order to obtain more granular evidence of the temperament systems on schematic memory, Experiment 3 was devised and conducted. In addition to that, although various studies that investigated temperament systems suggest that the acquisition and generalisation of a new temperament system (Leung & Dean, 2018; Loui et al., 2010) is a quick process, the role of a temperament system on schematic expectations remains either unquestioned or unclear. Here, I obtained data through 'goodness-of-fit' means by a modified version of the probe tone technique (Krumhansl & Kessler, 1982). Furthermore, Experiment 3 also aimed to understand whether 'goodness-of-fit' means could change after having temperament-based ear training classes and whether these fit means might be congruent with employed temperament systems in ear training courses.

3.4 General Design of Experiments

3.4.1 Ear Training Course Design

For all experiments, the ear training design was identical because of the presented assumptions about statistical learning. Based on this, the ear training classes were based on the demands of the temperament system through selected makams. Here, participants were not informed about which temperament system they have learned. Following this, two different curriculums were created with the same content covering selected three ear training makams. (Appendix C and Appendix D).

The focus of both classes was to expose participants to the features of the selected makams. Ear training's main component was the composed solfeggios. Here, my approach was to expose participants to components that form selected makams. Participants were not aware of the temperament system but were aware of which makam they learned. Accordingly, I created and used some well-known solfeggios (for all solfeggios please see Appendix BE), which were based on tetrachords and pentachordal components of the chosen ear training makams. The class was based on a gradual approach and started from a basic four-note tetrachord solfeggio and progressed through to a full characteristic of selected makams. To be consistent with participants' formally taught ear training methods and equalise the differences between countries, I did not use solmisation in vocalisations. Instead of solmisation, all participants vocalised solfeggios with a *"na"* syllable. Participants were also familiarised with some theoretical and cultural features of Turkish makam music. Except for the use of a different temperament system, all ear training materials were identical in both classes, which were also taught by the same teachers to eliminate any teaching style differences.

Additionally, to minimise teaching risks between countries, all curriculum aims were documented in two languages, and both teachers followed the written curriculum instructions. The written curriculum instructions covered every session, and all of these sessions were divided into six parts by 10-s minutes. These ear training sessions were designed as either theoretical knowledge or solfeggio practice, and every other session also briefly covered the previous sessions' solfeggio materials. Moreover, before experiments, both teachers received written guides for ear training (see Appendix B) and I also familiarised them with makam music in order to prevent any problems while teaching ear training courses. For more details, please see Appendices A, B, C and D.

3.4.2 Selection and Preparation of Stimuli

In order to create a makam-music stimuli pool, I asked five Turkish makam music experts to suggest makams and two songs per makam that matched the nine different emotional qualities of the GEMS-25 scale first-order factors (Zentner et al., 2008). Before the distribution of scale, all listed adjectives were translated into the Turkish language by myself. Subsequently, the translated adjectives were sent to the two English literature lecturers who study in Turkish universities. After revision of the GEMS emotion adjectives by these lecturers, the revised version was sent to two bilingual music lecturers who were working in Istanbul Technical University State Conservatory and Harran University Music Education department. The final version of Turkish GEMS-25 was obtained by combining both language and music expert suggestions (see Appendix F).

All selected Turkish makam music experts were active academic members and selected from Istanbul Technical University Turkish Music Conservatoire, Ege Turkish Music Conservatoire, Inonu University Music Education Department and UCLA Herb Albert Music School according to their publications and Turkish music performance career. Here, in addition to collecting makam stimuli suggestions according to GEMS first-order factors, I also asked experts to suggest their personal opinions on makam and its potential emotion induction adjectives as well. At the end of the data collection phase, experts suggested 25 makams and 50 excerpts in total.

Despite some overlaps in experts' suggestions, there was no full agreement on makam and emotion pairings among experts. However, in both experiments, I chose Huseyni, Mahur, Saba, Segah, Huzzam, Karcigar, Hicaz, Nikriz, Nihavend, and Mustear makams as suggested by experts, and two songs according to these makams. This selection was based on the most overlapping emotion-makam pairing between experts.

After selection of makams and songs, I created its original temperament (OT) and equal temperament (ET) versions. To produce 12-interval ET versions, I adapted the makams, which were initially in the 24-interval OT based on the nearest pitch principle. Figure 3.1 represents an example of the adaptation approach in Hicaz makam.

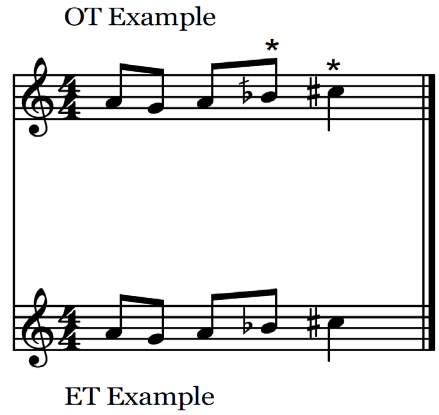


Figure 3.1. An example of the adaptation approach in Hicaz makam.

Note: An asterisk represents the pitches in the original temperament (OT) system and those adapted to the equal temperament (ET) system.

On the other hand, for Experiment 3, I chose three different excerpts from the expert pool. In this selection, our criterion was only to exhibit selected intervals within presented melodic motifs (for more details, see Section 6.2.3).

In addition to that, to test for a potential effect of timbre, I created three different versions of each stimulus using three different instruments (oud, piano and kanun) for Experiments 1 and 2. All stimuli were monophonic and were created via Mus2 Turkish notation and Finale software. All excerpts' temperament versions did not include any accentuation or articulation to eliminate the effects of other structural features on emotion induction. At the end of these processes, the Turkish makam excerpt pool consisted of 150 stimuli within three different timbres and ten different makams.

3.4.3 Criteria on Selection of Makams

As makams taught in ear training courses, I selected three different makams among expert-suggested makams. These are *Hicaz, Huzzam* and *Karcigar*. The selection process of these makams is mainly based on the difficulty between makams and dissimilarity to ET common major and minor scales. As familiarity cannot be measured directly and to measure which musical structure is caused to familiarity, I determined various music theoretical predictors in order to choose makams taught in ear training courses. The main criterion of selection of these makams is based on Western music dissimilarity. This dissimilarity criterion was evaluated under two subcategories. The first category is the intensity of pitch position dissimilarities. In this criterion, the comparison is based on the sum of pitch position differences of a makam scale with major and minor scales. The dissimilarity of pitch position for a given makam was calculated using the absolute cent differences of ET's corresponding pitch. For example, in the Hicaz makam (see Figure 3.2), three pitches in OT heptatonic representation are different from an identical heptatonic representation built in the ET version. Here, while the OT version of accidentals comprises a 90.2-cent semitone value, the ET version of the same makam comprises a 100-cent value. The calculation is based on the sum of differences between these cent values. For instance, a calculation of the Hicaz makam is (90.2−100) + (90.2−100) + (90.2−100) = -29.4 negative similarity value.

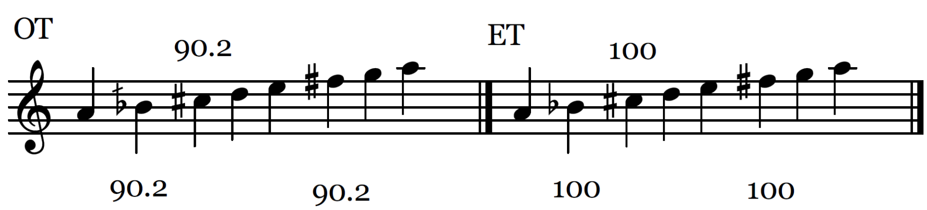


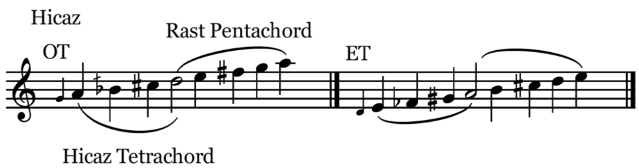
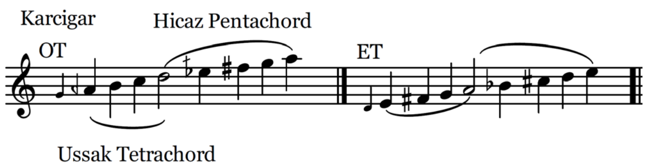
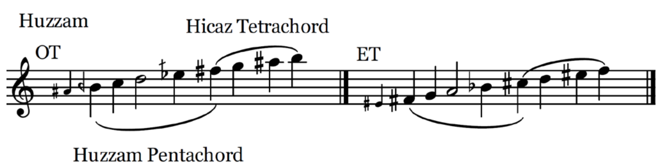
Figure 3.2. The cent values of B flat, C sharp and F sharp of Hicaz makam in OT and ET

The second category is based on the syntactic differences of selected makams with major and minor scales. Here, I used two different subcriteria in order to define syntax features. The first criterion of syntax features is the cadence degrees of a scale. The cadence term represents a musical phrase's formal conclusion with the most important scale degrees within a scale context (Caplin, 2004). The selection criterion is mainly based on the dissimilarity degree of the dominant scale degree. Major and minor tonalities in the ET system have the fifth degree of a given scale as a dominant degree. Therefore, all selected makams (Hicaz, Karcigar and Huzzam) were significantly different from each other, and different from the dominant cadence degree of the ET temperament system's major and minor tonalities. The second subcriterion of syntax features is the genus that forms the makam scales. Here, the evaluation criteria were based on two basic musical features. The first is the relation of genera; those that form the makam scale, such as the merge of trichord and pentachord, and the intervallic features of a given genus. In Western music, a scale is produced by obtaining a new tetrachord genus above another tetrachord. Therefore, all selected makams were substantially different from this combination of genera. The other evaluation criterion was the similarity of these genera with major and minor tonalities. For instance, the Hicaz makam is composed of a Hicaz tetrachord and Rast pentachord, while the latter component is identical to the major scale's first tetrachord; hence it might also contribute to the familiarity perception.

To conclude, in the view of those criteria, the familiarity of makams from most familiar to less familiar was ordered as Hicaz, Karcigar and Huzzam. Table 3.1 presents the brief musical features of selected makams in terms of the above-mentioned criteria. For more details and music-theoretical analyses, please see Appendix E.

Table 3.1

The dominant degree, genera and pitch dissimilarity values of selected makams

	Dominant degree	Genus combinations	Pitch dissimilarity value
	4th degree of scale	Hicaz Tetrachord+Rast Pentachord	-29.4
	4th degree of scale	Ussak Tetrachord+Hicaz Pentachord	-96.1
	3rd degree of scale	Huzzam Pentachord+Hicaz Tetrachord	-100.1

3.4.3 Statistical Methods that Used for Data Analyses

In order to analyse the data, I employed the Hierarchical Linear model (also known as Multilevel Linear Model/Mixed Effect Analyses) approach for all experimental data. The reason behind this choice is the capability of the method in incorporating the different forms of variables and its solution to factoring in the variability between individuals as well as offering a maximised representation of our data (Barr, Levy, Scheepers, & Tily, 2013). Hierarchical modelling consists of two different effect types. These are fixed and random effects. While fixed effects manifest the factors that directly influence the dependent variable, the random effects manifest the factors that often vary between individuals. For my data analyses, I used only fixed effect models.

Below is a linear fixed effects only regression model example with two fixed effect predictors.

$$Y_i \textit{ (Predicted score of group)} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \varepsilon_i$$

Y is the predicted score of emotion (e.g., Tenderness), and X represents the fixed effects (e.g., temperament system) in the model. While β0 represents the intercept term, β1 and β2 refer to the coefficients of the first (x1) and second fixed effects (x2), which are predictors of y. An epsilon (ε) is a term for residual error which is specific to each participant.

In order to obtain the best fit for all hierarchical models, I used the backwards-step approach. Here, the main aim is to reduce the terms by starting from the highest interaction terms to the single main factors. In this approach, the first model represents the full model and informs us which fixed effects are significant. Subsequently, the highest statistically non-significant interaction term was removed from the model until the best AIC value was obtained (Akaike, 1974). The information criteria of best models was obtained from *Akaike's Information Criterion* (AIC) and based on the *restricted maximum likelihood* (REML) conditional estimate of variance.

For verbal identification data, I used a generalised mixed effects modelling approach. The generalised mixed effects model approach provides flexibility to choose an appropriate statistical distribution for our data, such as the binomial distribution and to identify/modify the target dependent on a variable's reference categories. The statistical model approaches were applied by SPSS 26, a statistical package program.

To increase interpretability and reduce the number of dependent variables, the GEMS-25 questionnaire was reduced to three underlying second-order factors: Sublimity (combining wonder, transcendence, tenderness, nostalgia, peacefulness), Vitality (combining power and joyful activation), and Unease (tension and sadness) by producing a mean score for each second-order factor.

Internal consistency is associated with the extent to which a construct is measured by a group of items (Henson, 2001). In order to understand the reliability of GEMS-25 scale, Cronbach's alpha was employed. SPSS statistics was used to identify the Cronbach's alpha. The GEMS-25 had high interval consistency since the alpha coefficient's of the 25 items is .87.

3.4.5 General Flow in Experimental Design

The procedures of this study were approved by ethics committees of the University of York and the University of Harran. The general flow in experiments and its brief summaries are as follows:

Experiments 1 and 2: A mixed factorial design structure was employed. Firstly, in both experiments, a pretraining experiment examined participants' emotional responses to five selected unfamiliar makams presented in their original temperament version and an adapted equal temperament version. Also, ten makam names were presented with an "I do not know" option to see whether participants were able to identify the name of the makam correctly.

Subsequently, participants were randomly allocated to one of two different temperament-based ear training courses that were based on either 24-interval original temperament (OT) or 12-interval equal temperament system (ET). Following that, participants participated in final listening experiments.

Experiment 3: For the 'goodness-of-fit' rating study, a mixed factorial design structure was employed. Accordingly, participants attended a probe rating experiment before attending ear training classes. Subsequently, all participants were randomly assigned one of two ear training groups to attend two-week Huzzam makam temperament-based ear training classes. After this, all participants attended the same listening experiment before attending the class.

4. Experiment 1

4.1 Aims

The purpose of Experiment 1 was to test research questions on how induced emotions and verbal identification of Turkish makams are influenced by temperament systems and if they are influenced by participation in temperament-based ear training classes. This suggestion is based on our proposal that temperament systems act as an ecosystem of all possible musical pitch relations based on statistical learning in music (Huron, 2006) and the assumptions of musical expectations theory (Meyer, 1956). The reason behind Experiment 1 was to address the applicability of the proposed new method and to gather preliminary observations on temperament experience through culturally and formally unfamiliar participants.

Accordingly, in this study, our underlying research questions were the following:

- RQ1: *Does the temperament system in which a Turkish makam is presented influence a listeners' emotional response to it?*
- RQ2: *Are listeners able to identify the name of a listened-to Turkish makam after attending an ear training, and does this identification depend on the temperament system employed in training?*
- RQ3: *Do listeners' emotional responses to the unfamiliar temperament system change through exposure in ear training?*

4.2 Method

4.2.1 Participants

Nineteen music students who were encultured in the Western temperament system participated in this study (mean age = 23 years, SD = 4.8 years, ten males; formal music education mean = 11 years, SD = 5 years). Except for one (excluded from analysis), all other participants were unfamiliar with makam music.

4.2.2 Procedure

The pre-experiment was conducted in a listening laboratory and embedded into an online questionnaire. Here, participants were asked to rate their emotional response retrospectively to each stimulus presented in random order, using the GEMS-25 questionnaire (Zentner et al., 2008). Each instrumentation version was only randomly presented once to each participant, creating an additional between-subjects factor. Since it did not significantly influence participants' emotion ratings, I am not presenting the related results here. Furthermore, they were asked to identify the name of the *makam* from a list of 10 different makams or select an "I do not know" option. To increase absorption in music, participants wore active noise cancellation headphones. All the experiment sessions lasted approximately 25 minutes per participant.

Subsequently, participants were randomly assigned to one of two groups in order to attend a one-hour-long ear training class. One participant group received a music-theoretical introduction to the *Hicaz* makam in OT and the other group in ET. Both ear training sessions were run in a normal classroom setting and were about one hour long. On the day after the ear training sessions, all participants participated in the same listening experiment as the one before attending the class (for further ear training details please see Appendix A and C).

4.2.3 Musical Stimuli

All selected excerpts in Experiment 1 were selected from Huseyni, Mahur, Saba and Mustear makams, which was suggested by Turkish makam music experts. Excerpts are generated as MIDI via Mus2 and Finale software.

Table 4.1

Stimulus Characteristics

Excerpt Number	1	2	3	4	5	6	7	8	9	10
Makam Name	Hicaz		Huseyni		Mahur		Saba		Mustear	
Tempo (bpm)	144	122	100	114	132	128	87	72	66	60
Time Signature	7/16	5/8	4/4	10/8	8/8	2/4	20/4	6/4	9/8	8/8
Duration (in seconds)	68	84	61	42	59	68	27	66	32	33
Instrumentation versions	Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun	
Temperament versions	OT, ET		OT, ET		OT, ET		OT, ET		OT, ET	

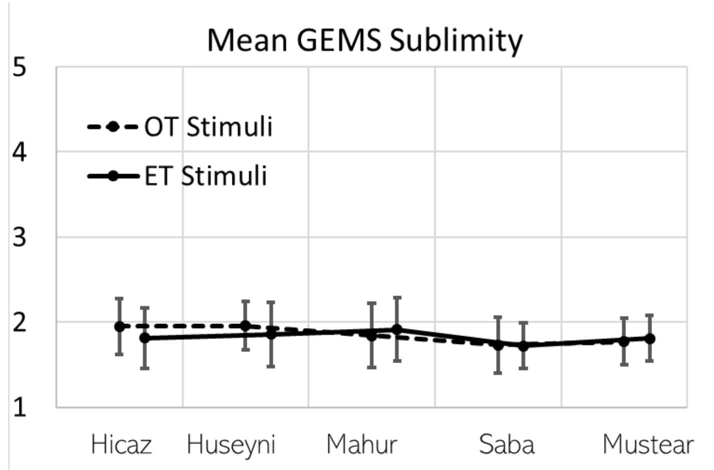
4.3 Results of Experiment 1

4.3.1 Effect of Temperament System and Makam Type in Pre-Experiment

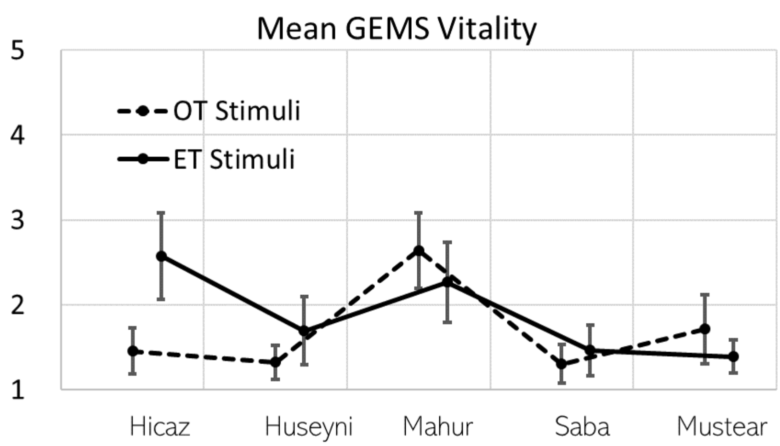
I employed a Hierarchical Linear modelling procedure in order to test for significant effects on three second-order GEMS-25 (Zentner, Grandjean & Scherer, 2008) emotion factors (using the mixed procedure in SPSS). All estimations are based on restricted maximum likelihood with compound symmetry heterogeneous covariance structure (which produced the best AIC fit indices overall).

Figure 4.1A presents the mean intensity of the second-order sublimity factor in the Pretraining experiment (before the ear training class) separated by stimulus temperament system and makam type. According to our Hierarchical Linear model, neither temperament system ($F(1,153) = 0.23$, $p = .64$) nor makam types ($F(4,153) = 1.47$, $p = .21$) influenced experienced sublimity. The interaction between the temperament and makam types was also statistically non-significant ($F(4,153) = 0.51$, $p = .73$).

A – Sublimity



B – Vitality



C – Unease

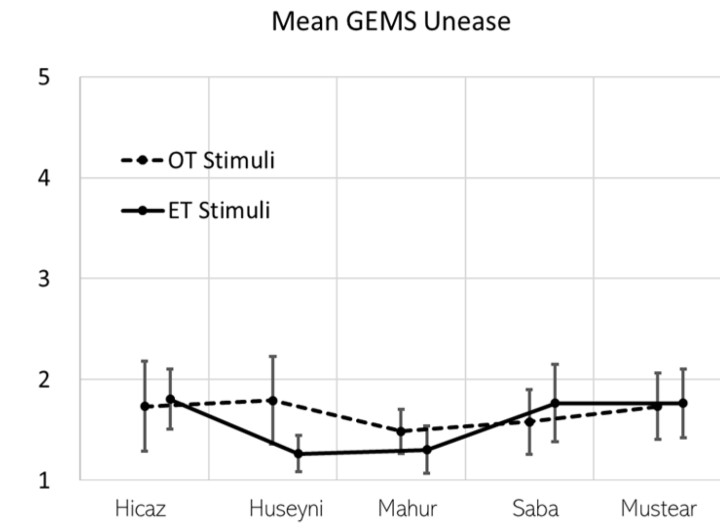


Figure 4.1. Mean intensity of second-order GEMS factors in pre-experiment separated by stimulus temperament system and makam type with 95% CI.

Figure 4.1B presents the mean intensity of the second-order vitality factor in the pre-training experiment separated by stimulus temperament system and makam type. According to our model, temperament system (F (1,153) =6.80, *p*<.01) and makam types (F (4,153) =28.47, *p*<.001) influenced vitality significantly. The interaction between temperament system and makam type interaction was also significant (F (4,153) =13.29, *p*<.001). The Hicaz and Mahur makams experienced as more vital than all other three makams. All makams' vitality means also differed in accordance with their temperament system. While generally, ET makam versions were mostly experienced as more vital than their OT versions (apart from the Mahur and Mustear makam), this effect appeared to be strongest for the *Hicaz* makam: Fixed effects estimates indicate the ET version was experienced as significantly more vital (b=1.44, t=5.27, *p*<.001) compared to the OT version.

Figure 4.1C presents the mean intensity of the second-order uneasiness factor separated by stimulus temperament system and makam type. According to our linear model, the temperament system did not (F (1,153) =1.66, *p*=.20), but makam types did (F (4,153) =4.53,

$p<.001$) influence uneasiness significantly. The interaction between temperament system and makam type interaction was also significant ($F(4,153) = 3.50$, $p<.01$). This indicates that the equal temperament version of the Huseyni makam was experienced with less unease (sadness and tension) than its original version.

4.3.2 Effect of Ear Training and Temperament System on Verbal Identification of Hicaz Makam

The participants were asked the name of the makam presented in the pre-and post-training experiments. I expected a possible increase in verbal identification performance of the Hicaz makam after attending ear training courses and tested if this depended on the temperament systems employed in the training and listening experiments. In order to test this, I used a generalised linear mixed model with the probability of recognising the Hicaz makam correctly as an outcome variable. Here, time (pre, post), ear training course (OT, ET) temperament system (ET, OT) were added as main factors into the model with all possible interactions. Figure 4.2 shows predicted Hicaz makam verbal identification performance probability separated by time, ear training type and stimulus temperament system. According to the model, only the experimental factor time was significant ($F=6.678$, $p<.01$), indicating that generally, the verbal identification performance of the Hicaz makam improved after the ear training class (Figure 4.2). However, no other experimental factors or interactions were significant, indicating that the verbal identification performance of the Hicaz makam did not depend on the temperament system employed in the ear training class or for stimulus presentation (see Appendix G).

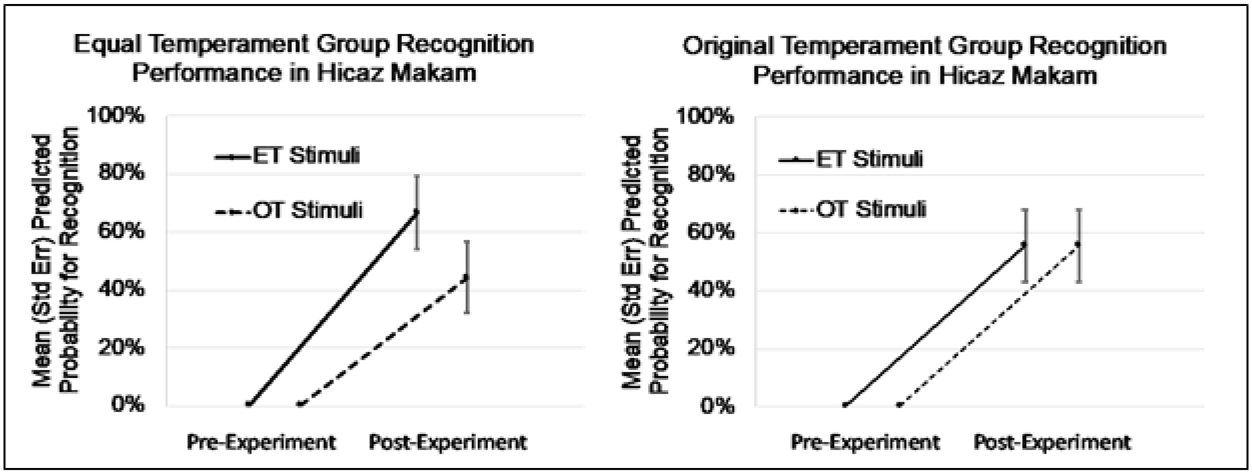


Figure 4.2. Predicted Hicaz makam verbal identification probability separated by time (pre vs post experiment), ear training type and stimulus temperament system.

4.3.3 Effect of Ear Training on Emotional Experience of Hicaz Makam

As I noticed a change in participants' ability to recognise the previously unfamiliar Hicaz makam, I then subsequently tested if the ear training leads to any associated changes in their emotional experience of this makam. For this reason, I again employed a linear mixed model for each of the three second-order GEMS factor means, using only data for the *Hicaz* makam. I excluded the other makams from the modelling approach. The first justification behind this is that the only potential hypothesis of change for makam was for the Hicaz makam. Furthermore, exploratory analyses (not shown here) for other makams indicated that other makams' emotional impacts did not change as a function of the ear training and temperament system.

Even though Figure 4.3A indicates that the experience of sublimity might have decreased after the ear training for the OT participant group (which is also indicated by a non-significant trend in the interaction of the factors time and ear training group), no experimental factor and no interaction was significant when modelling sublimity (see Appendix H).

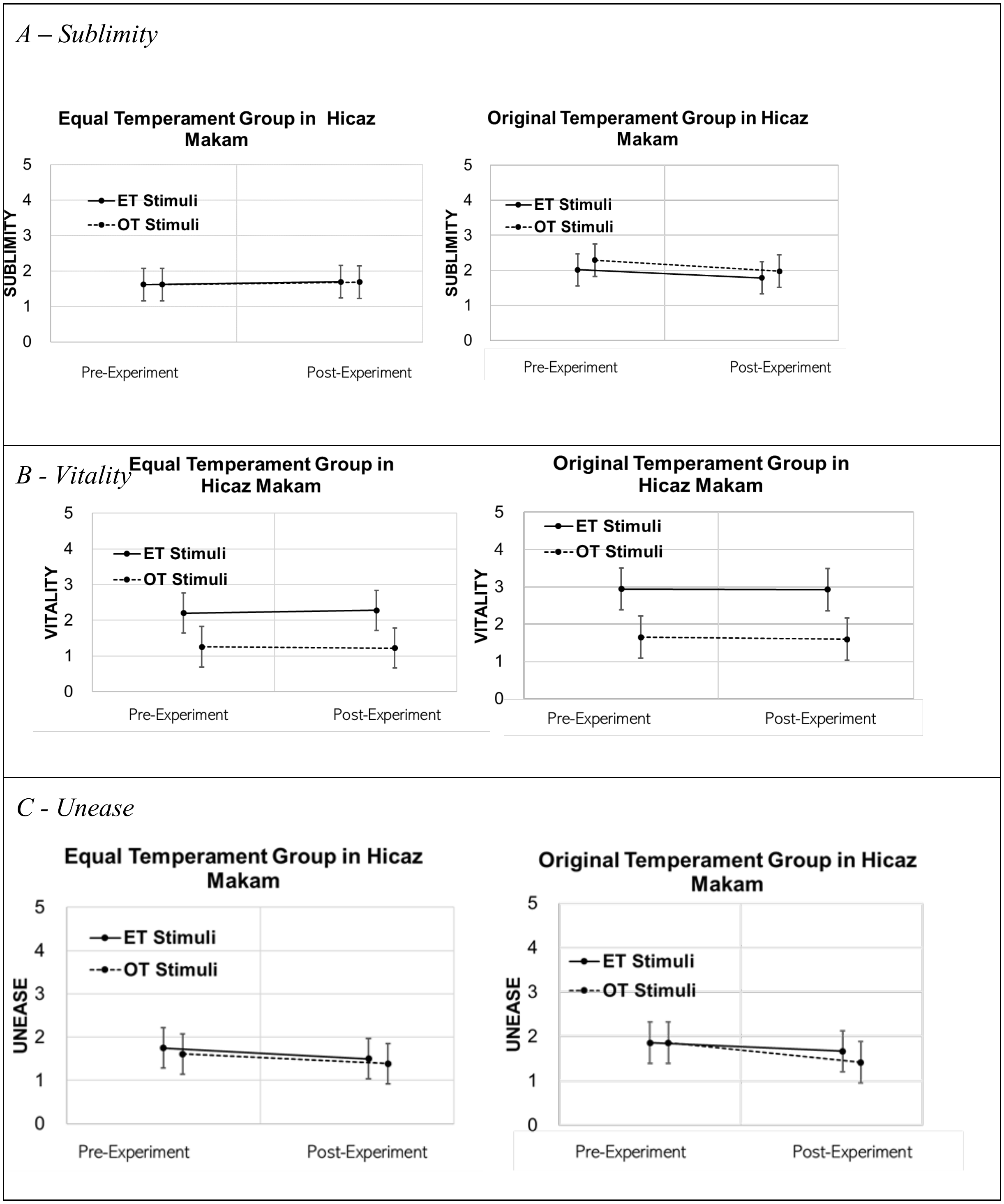


Figure 4.3. Mean experience of three second-order GEMS factors for Hicaz makam separated by time (pre vs. post experiment), ear training type and stimulus temperament system with 95% CI.

Figure 4.3B shows again (like in the pre-training experiment) that generally, the ET was experienced as more vital than the original (F (1,48) =74.910, $p<.001$). However, all other factors and interactions were non-significant (see Appendix I).

For an uneasy experience, only the time factor was significant, indicating that generally, exposure to the makam decreased the experience of this feeling (Figure 4.3C). No other factor or interaction was significant (Appendix J).

4.4 Discussion

I tested temperament systems' effects on emotion induction and verbal identification performance of makams by adapting an unfamiliar temperament system to a familiar temperament system. The results demonstrate that different makams induced different emotions, and the intensity of these emotional qualities also changed according to the presented temperament system (RQ1). As expected, verbal identification of the Hicaz makam increased from pre- to post-experiment (RQ2). However, this increase did not depend on the temperament system employed in the training or listening experiment. Being exposed to the Hicaz makam during the ear training did decrease the experience of its uneasiness (comparing means in pre- and post-experiment). However, this change did not also depend on the tuning system employed (RQ3).

Previous cross-cultural music cognition studies showed that musical expectations are biased by culture (Demorest, Morrison, Nguyen & Bodnar, 2016). Demorest and colleagues hypothesised that listeners in an out-of-culture memory task might attempt to use in-culture schemata to organise culturally unfamiliar music rather than a new, more appropriate construct. This idea is supported by findings like those of Curtis and Bharucha (2009), who presented listeners with music stimuli that exploited their cultural biases, leading to incorrect recall responses for culturally unfamiliar music. Demorest, Morrison, Jungbluth, and Beken (2008) compared American with Turkish participants, and they found a positive effect of in-culture familiar music characteristics on music memory performance. In the pre-training experiment, our participants also had less cognitive schema available to process the OT stimuli (compared with their ET versions). Therefore, without any OT schemata, the OT versions might have been experienced as less vital and less positive.

Furthermore, I only observed an increase in general cognitive schemata for makam syntax as a result of the ear training, indicated by an increase in the verbal identification rate. Here, I did not observe the benefit of stimuli, where the temperament of stimuli was congruent.

I also only observed a general, temperament-independent decrease in the experience of uneasiness for the Hicaz Makam. This general reduction of unpleasant feelings after exposure might also be similar to the mere exposure effect, described by Zajonc (1968), which has been shown in music (e.g., Halpern and Mullensiefen, 2008; Mungan, Akan, & Bilge, 2019; Peretz, Gaudreau, Bonnel, 1998). I assume that the duration of the exposure in the one-hour-long class might not have also been long enough to change listeners' mental representation of the temperament system employed. Therefore, the latter variable showed no visible effects on post-experiment responses.

In terms of emotion studies in music, the pitch factor is a more ambiguous structural factor than factors such as tempo and loudness, as its relationship with emotion is less clearly defined (Gabrielsson & Lindström, 2010). Therefore, studying the emotional qualities of temperament systems in different cultural contexts might give new insights into understanding how a pitch is linked to emotion. My study shows that, generally, unfamiliar temperament systems induce less vital and more uneasy emotions. Furthermore, being exposed to this temperament system for just one hour does not seem to be enough to change participants' mental representations of it or their emotional responses to it. Further longitudinal experiments with a larger sample size would need to be conducted, where the amount of exposure is substantially increased.

5. Experiment 2

5.1 Aims

The results of Experiment 1 suggested that, generally, unfamiliar temperament systems are experienced as less vital and more uneasy than familiar temperament systems. Also, being exposed to this temperament system for just one hour did not seem to be enough to change participants' emotional responses to it. On the other hand, despite the observed increase in verbal identification of Hicaz makam, this increase was not congruent with employed temperament systems in ear training courses. Since there was no strong evidence on the effect of temperament systems on emotion induction and verbal identification performance, the second study aimed to re-test previous experimental design by extending exposure times with a larger sample size and including a cross-cultural comparison.

My consideration in extending the previous study is based on two criteria. Firstly, as I mentioned before, I wanted to see whether extending exposure time would reveal any differences from the original study's findings, hence revealing a stronger effect of temperament accommodation in mental representation. Another aspect of my consideration was to see whether TR participants' cultural background might affect this experience despite being educated under the ET temperament system. This way, in addition to testing temperament experience through familiarity (because all participants declared that they have been exposed to the ET formally and intensively), I also wanted to see whether the surrounding cultural sonic environment (Clarke, 2005) affects emotion induction and verbal identification of makams. Accordingly, the present study's research questions were as follows:

- RQ1: *Does the temperament system in which a Turkish makam is presented influence a listeners' emotional response to it, and are these responses different by country?*
- RQ2: *Are listeners able to identify the name of a listened-to Turkish makam after attending an ear training course, and does this identification depend on the temperament system employed?*
- RQ3: *Do these verbal identification performances differ by country?*

- RQ4: *Do listeners' emotional responses to the unfamiliar temperament system change through exposure in an ear training course, and are these responses congruent with the temperament system employed in ear training courses?*
- RQ5*: Do listeners' emotional responses differ by country and exposure to a makam syntax?*

5.2 Method

5.2.1 Participants

Participants were recruited by invitation across the University of York in the UK and the University of Harran in Turkey. Accordingly, 31 music students in the UK (mean age= 21.90, SD=3.40, 24 females, formal music education mean=12.61 years, SD= 3.56) and 31 students in Turkey (mean age= 22.46, SD=3.40, 24 females, formal music education mean=12.61 years, SD= 3.56) who declared that they were educated formally in the Western temperament music system participated in the study.

5.2.2 Ear Training Content

I selected the Huzzam and Karcigar makam as the makams taught in ear training. The reason behind these choices was, despite not corresponding to any common scale in Western music entirely, I wanted to see whether any minimum music structural similarity to a Western music component (i.e., major tetrachord) might influence the experience of temperament systems. Here, I used pitch position dissimilarity as a violation of the expectation criterion. For instance, while the first tetrachord of Karcigar makam shares one uncommon pitch position, the Huzzam makam shares three uncommon pitch positions when compared to its ET versions. I also used the syntactic rules and construction as a violation criterion in selecting these makams (for more details, see section 3.4.3). Accordingly, while the Karcigar makam was the closest makam to the music structures used in Western music (as its violation intensity was relatively less than the Huzzam makam), the Huzzam makam formed up the very end of this dissimilarity scale.

As mentioned before (see Section 3.4.1), the teaching method's basic approach was based on a gradual approach and started from a basic four-note tetrachord solfeggio and progressed through to full characteristics of selected makams. This gradual approach also applied to the makam teaching order due to adopting a 'from easy to difficult method'. Accordingly, while the Karcigar makam was taught in the first two weeks, the Huzzam makam was introduced in the last two weeks of the four-week period. Another reason to adopt this kind of sequential approach was to understand the exact effect of temperament systems on emotion induction and the verbal identification performance of makams. Accordingly, I predicted that if a temperament system is an explicit and independent feature among other potential musical structures that cause emotion arousal, despite not having a makam-syntactic exposure, the emotional experience may depend on the temperament system that they were exposed to in the ear training classes. On the other hand, by measuring Karcigar makam experience in between mid-to-post measurement, I wanted to see whether participants' measured experiences change and whether the congruent or incongruent experience in temperament systems change due to continued exposure times.

All classes were one hour/week, and in total, participants received four-hour temperament-based ear training either in OT or in ET on selected makams. Also, to prevent any teaching differences in both countries, teachers followed written curricula, which defined the teaching method for two makams.

5.2.3 Musical Stimuli

All excerpts in order to use in Experiment 2 were selected makams from the expert pool (see Section 3.4.2). To minimise any similarities to pre-experiment, I selected makams that were significantly different from the previous study and common scales used in Western music. Accordingly, Karcigar, Segah, Huzzam, Nihavend and Nikriz makams were selected for listening experiments.

As I did in Experiment 1, two excerpts per makam were selected, and I created the OT and ET versions according to nearest pitch principle method (see Section 3.4.2). In order to eliminate the effects of other structural features on emotion induction, the temperament versions of each excerpt did not include any accentuation or articulation (see Table 5.1 for the full stimulus characteristics). Furthermore, I either chose excerpts that originally had identical tempos or equalised the tempos. In addition to that, I created three different versions of each stimulus using three different instruments to test for a potential effect of timbre.

Table 5.1

Stimulus Characteristics

Excerpt Number	1	2	3	4	5	6	7	8	9	10
Makam Name	Karcigar		Nikriz		Huzzam		Nihavend		Segah	
Tempo (bpm)	96	100	88	90	90	90	102	100	90	80
Time Signature	10/8	9/8	9/8	9/8	2/4	8/8	10/8	10/8	7/4	6/8
Duration (in seconds)	25	34	39	48	22	34	27	30	29	38
Instrumentation versions	Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun		Oud, Piano, Kanun	
Temperament versions	OT, ET		OT, ET		OT, ET		OT, ET		OT, ET	

5.2.4 Procedure

In both countries, the pre-training experiment was conducted in a listening laboratory and was embedded in an online questionnaire. The online questionnaire of the experiment comprised of two sections. In the first section, participants were asked to fill in certain socio-demographic questions and were informed about the flow of the experiment. In section 2, participants listened to selected excerpts and their temperament versions in random order. Every excerpt was presented on a new page, and on every page, participants were instructed about the difference between felt and perceived emotions in order to obtain a more conscious report of felt emotions. Screenshots from the online questionnaire can be found in Appendix BC.

Participants randomly listened to 10 excerpts, and two sections took approximately 40 to 60 minutes to complete (depending on participants' rating speed). All means were gathered retrospectively via GEMS-25 (Zentner et al., 2008) English and Turkish versions.

Subsequently, participants were allocated to two different ear training groups, which were based on temperament systems. At the end of the second week, participants attended another mid-training measurement which was identical to the pre-experiment. Afterwards, participants took part in a post-training measurement which was also identical to the previous two experiments.

5.3 Experiment 2 Results

5.3.1 Effect of Temperament Systems and Makam Types in Pre-Experiment on Emotion Induction

I employed Hierarchical Linear models for GEMS second-order emotion means by using the mixed procedure in SPSS to assess the effect of temperament systems and makams and to test country-wise differences in the pre-experiment period. In the process of choosing the best model to describe our data, I employed a backwards-model approach (West, Welch, & Galecki, 2006) and applied it each time a mixed effects analysis was conducted in this thesis. This approach begins with me conducting a model with all the possible fixed effects and its interactions. For example, in all pre-experiment GEMS-25 second-order factor analyses, I put the below variables as fixed effects and interaction terms:

1- Temperament systems (ET or OT)
2- Makam type (Karcigar, Nikriz, Nihavend, Huzzam and Segah)
3- Instrumentation (oud, piano, kanun)
4- Temperament systems x makam type
5- Temperament systems x instrumentation
6- Instrumentation x makam type
7- Temperament systems x instrumentation x makam type

After retrieving output of the first model, I removed all fixed effects that are not statistically significant based on backwards-model approach. Here, the removing process must start from the highest interaction (in this case it is the interaction between temperament systems, instrumentation and makam type) and must continue from the highest to the lowest "single fixed effect" term. To choose the preferred model, the covariance structures that produced the best AIC values were considered. Each instrumentation version was only randomly presented once to each participant, creating an additional between-subjects factor. Since it did not significantly influence participants' emotional experience, I am not going to present the related results here. Visual inspections did not reveal any deviations from normality (West, Welch, & Galecki, 2006). All estimations were based on *compound symmetry* covariance structure which produced the best AIC fit indices.

5.3.1.1 Sublimity Experience in Pre-Experiment

Figure 5.1a presents the mean intensity of the second-order sublimity means in the Pre-training experiment (before ear training class) separated by stimulus temperament systems and makam type in the UK. According to the Hierarchical Linear model, the makam type ($F(4,241) = 7.06$, $p < .01$) factor significantly influenced the means of sublimity. The results showed that the Huzzam makam was experienced as less sublime when compared to other makams. However, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

Sublimity

(a)UK *(b) TR*

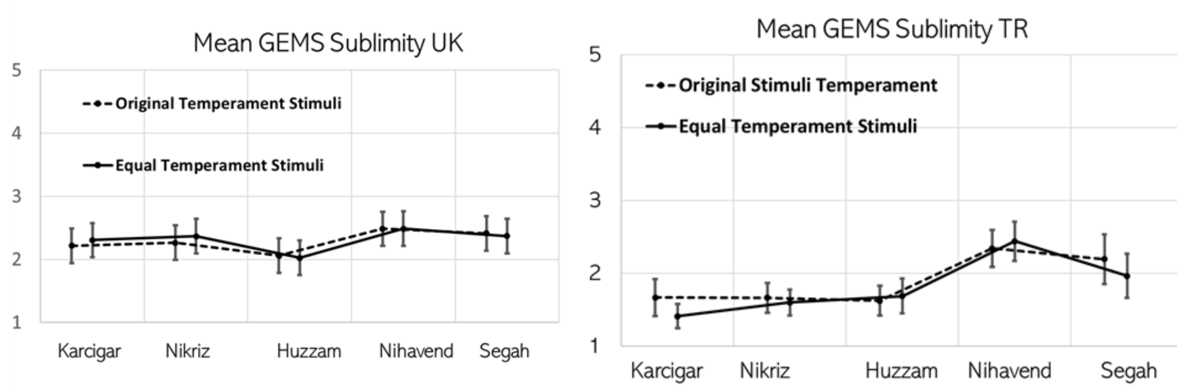


Figure 5.1 Error-bar graphs of fixed effects estimated for sublimity means separated by temperament stimuli and makam type with 95% CI (a) UK (b) TR

Subsequently, I applied the same statistical procedure for Turkish participants' sublimity means (Figure 5.1b). Results revealed that the makam type (F (4,241) =21.86, p<.001) factor influenced the sublimity means of TR participants. Accordingly, the Nihavend makam was rated as the most sublime makam among five makams, and the Karcigar makam was the least sublime. However, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

To understand the differences between countries, I estimated another linear model that included the country as a main factor. According to this model, country (F (1,54) =6.83, p<.001) and the interaction between country and makam type (F (4,484) =6.76, p<.001) factors were significant, indicating that the means differed according to country and makam type. Based on this result, the UK participants (M=2.30 SD= .10) experienced more sublimity than the TR participants did (TR: M=1.94 SD= .10). The result revealed that this difference was statistically significant (t (538) =2.61, p<.001). Furthermore, the post-hoc results for the interaction between country and makam types showed that the UK participants (UK: M = 2.31 SD= .11) rated the Nikriz makam as more sublime than the TR participants did (TR: M = 1.79 SD =.11). This difference was also statistically significant (t (518) =3.27, p<.001). However, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

5.3.1.2 Vitality Experience in Pre-Experiment

Following this, another linear model was employed to assess temperament systems' effect and the interaction of temperament systems and makam type on vitality means. According to the model, the makam type (F (4,241) =22.06, p<.001) factor significantly influenced vitality means of UK participants. In agreement with the results, while the Huzzam makam was experienced as more vital, the Nihavend and Segah makams were experienced as less vital by the UK participants when compared with other makams. The analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

Figure 5.2b presents the mean intensity of the second-order vitality means in TR in the pre-experiment separated by stimulus temperament system and makam type. According to the model, the Makam type (F (4,97) =15.93, *p*<.001) factor influenced vitality means significantly. Correspondingly, while Karcigar and Nikriz makams were rated as most vital makams, Segah and Nihavend were rated as less vital.

Vitality

(a) UK *(b) TR*

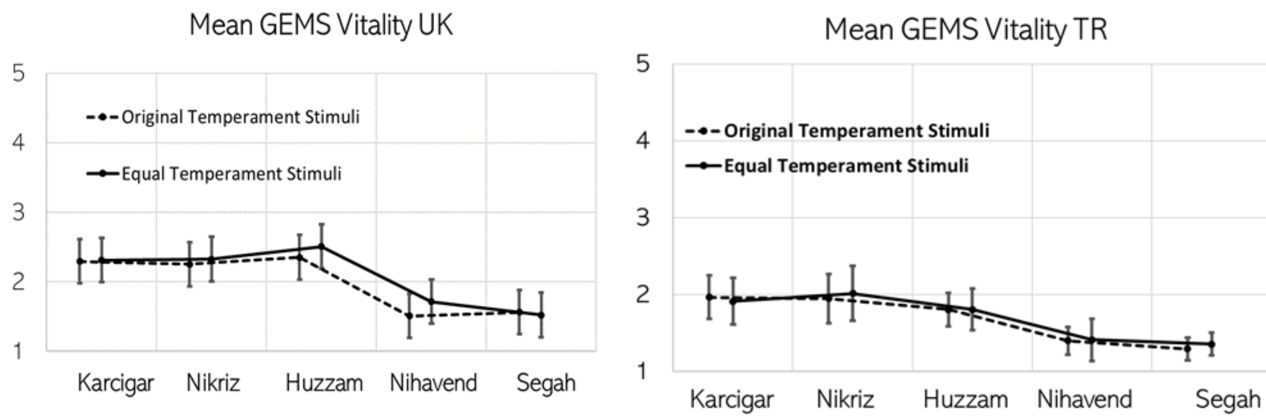


Figure 5.2. Error-bar graphs of fixed effects estimated for vitality means separated by temperament stimuli and makam type with 95% CI (a) UK (b) TR

Another linear model for understanding country differences showed that vitality means were different in accordance with the country (F (1,538) =4.37, *p*<.05) and makam type (F (4,538) =18.45 *p*<.001). On the other hand, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type. According to the post-hoc test, the UK participants (M=2.03 SD= .11) experienced more vitality in general than the TR participants did (M=1.71 SD= .11; *p*<.05). The results revealed that this difference was statistically significant (t (538) =2.09, *p*<.05).

5.3.1.3 Unease Experience in Pre-Experiment

Figure 5.3a presents the mean intensity of the UK participants' second-order uneasiness means separated by stimulus temperament system and makam type factors in both countries.

Accordingly, the analysis did not reveal any significant effect of temperament systems or the interaction of temperament systems and makam type.

Unease

(a) UK (b) TR

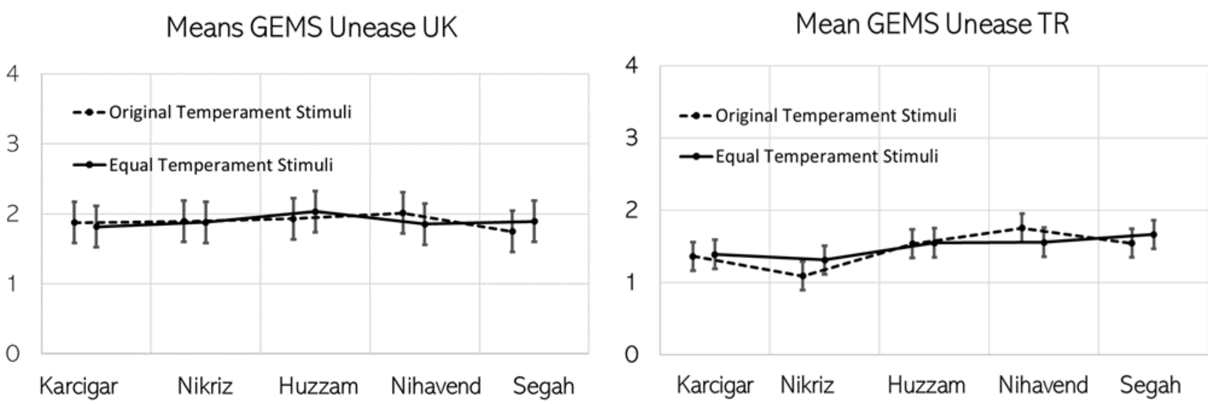


Figure 5.3. Error-bar graphs of fixed effects estimated for unease means separated by temperament stimuli and makam type with 95% CI (a) UK (b) TR

I employed another model for TR participants' unease means (figure 5.3b). According to the model results, only the makam type (F (4,241) =8.79, *p*<.001) main factor influenced the unease means of TR participants significantly. Accordingly, Nihavend and Segah makams were rated as the most uneasy makams among five makams. On the other hand, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

Subsequently, I employed another model to understand the differences between countries for unease means. The analysis showed that country (F (1,538) =11, *p*<.001) and the interaction between country and makam type (F (4,538) =3.90, *p*<.001) were significant, indicating that uneasiness means were different in accordance with country and makam types. Accordingly, in general, TR participants (TR: M=1.47 SD= .09) experienced less unease (sadness and tension) than UK participants (M=1.89 SD=.09; *p*<.001). This difference was statistically significant (t (538) =3.32, *p*<.001).

Besides, Karcigar (M=1.85 SD= .11; *t* (538) =3.12, *p*<.001), Nikriz (M=1.89 SD= .11; *t* (538) =4.54, *p*<.001) and Huzzam (M=1.98 SD= .11 *t* (538)=2.92, *p*<.001) makams were rated as the most uneasy makams by the UK participants than the other makams.

As the number of participated attendees was higher than Experiment 1 and since both country participants' formal education was in ET and they declared that they do not have any theoretical or auditorial familiarity with any kind of makam music, I combined both countries' GEMS second-order means to reveal if there is a strong familiarity effect and increase statistical test power. Accordingly, figure 5.4a presents the mean intensity of the second-order sublimity means for all participants (without country differentiation) in the pre-experiment separated by stimulus temperament system and makam type. According to the linear model, Makam type (F (4,493) =24.54, *p*<.001) factor influenced sublimity means significantly. In line with this finding, the Nihavend makam was experienced as the most sublime makam among the presented makams. The analysis did not reveal any significant effect of temperament systems or the interaction of temperament systems and makam type.

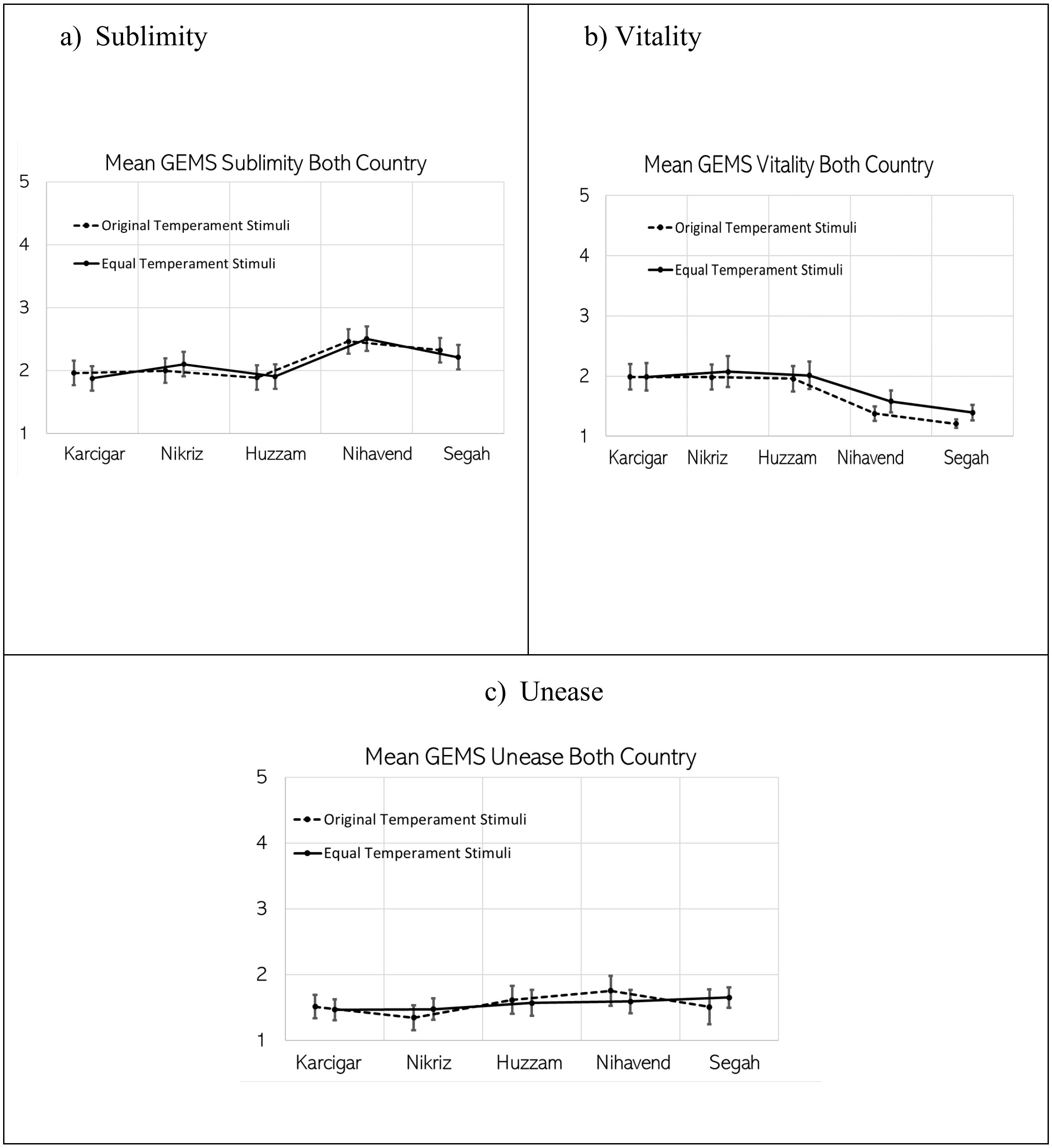


Figure 5.4. Error-bar graphs of fixed effects estimated for GEMS-25 second-order factors separated by temperament stimuli and makam type with 95% CI (a) UK (b) TR

Figure 5.4b presents the mean intensity of the second-order vitality means for all participants (without country differentiation) in the pre-experiment separated by stimulus temperament system and makam type. Accordingly, temperament system (F (1,20.51) =4.02, p<.05) and makam type (F (4,355) =33.14, *p*<.001) main factors influenced vitality means significantly. In line with this finding, results revealed that in general, the ET temperament stimuli (M= 1.81, SD=.07) were rated as more vital than the OT system (M=1.67, SD=.05), and this difference was statistically significant (*t* (550) =2.00, *p*<.05). Further post-hoc analyses showed that the Segah makam was rated as less vital among five makams.

Figure 5.4c presents the mean intensity of the second-order unease means of all participants (without country differentiation) in the pre-experiment separated by stimulus temperament system and makam type. Accordingly, only the makam type (F (1,155) =5.08, p<.001) influenced unease means significantly. The Nihavend makam was rated as the most uneasy makam among other makams. On the other hand, the analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type.

5.3.1.4 Summary of Pre-Experiment Results in Emotion Induction

The results per country in the pre-experiment showed that neither the temperament system nor the interaction between temperament and makam type had influenced the means of three second-order factors (sublimity, vitality, and unease). The compared results of two countries revealed that while the UK participants' overall vitality and sublimity experience was higher than the TR participants', the TR participants experienced less unease (sadness and tension) than the UK participants did.

In order to increase the statistical test power, I merged both countries' data since all participants have been educated in the ET temperament system. Merged data results revealed that overall, the ET temperament version of makams was experienced as more vital than the OT version. The analysis did not reveal any significant effect of temperament systems or the interaction between temperament systems and makam type for sublimity and unease second-order means.

Another important finding of the pre-experiment results was the emotion-specific qualities of makams. In both countries, the Nihavend makam was rated as the most sublime makam out of the five makams. On the other hand, while the Huzzam makam was rated as more vital by the

UK participants, the TR participants experienced the Karcigar and Nikriz makams as more vital. Also, in both countries, the Nihavend and Segah makam were experienced as less vital makams. While the UK participants' analysis did not reveal any difference in uneasy experience, TR participants rated Nihavend and Segah as inducing more unease than other makams.

5.3.2 The Effect of Ear Training Courses on Verbal Identification Performance of Makams

In Experiment 1, although the verbal identification performance of the Hicaz makam was increased, this increase was not a function of the temperament system employed in the ear training class or stimulus presentation. In order to understand whether extended exposure times could influence the verbal identification task, I re-applied the same verbal identification procedure by asking our participants the name of the makam presented in the pre-mid and post-training experiments. I expected an increase in the Karcigar and Huzzam makam verbal identification performance after the ear training and tested whether it depended on the temperament systems employed in the ear training courses and listening experiments. In order to test this, I used the generalised linear mixed model method with the probability of identifying the Karcigar and Huzzam makams correctly as an outcome variable. Predictors of best fit were obtained by a backwards-model approach. All estimations were based on compound symmetry and compound symmetry heterogenous covariance structures which produced the best AIC fit indices. As fixed effects, I entered time (pre, mid, post), ear training course (OT, ET), temperament system (ET, OT) and instrumentation (oud, piano, kanun) as main factors with all possible interactions. Since timbre did not influence the recognition performance, I excluded timbre main factor from the models.

5.3.2.1 UK

Figure 5.5 shows the verbal identification performance of UK participants in the Karcigar makam across three measurement points. As an expected result, initially, the identification rates of both makams were zero. The analysis showed that only the time factor was significant ($F(2,28)=154.10$, $p<.01$), indicating that generally, the verbal identification performance improved after taking ear training classes. However, this identification performance was relatively stable between mid-to-post measurement when compared to pre-to-mid measurement. However, neither the temperament system nor ear training factors influenced the verbal identification performance of the Karcigar makam (for the full table, see Appendix K).

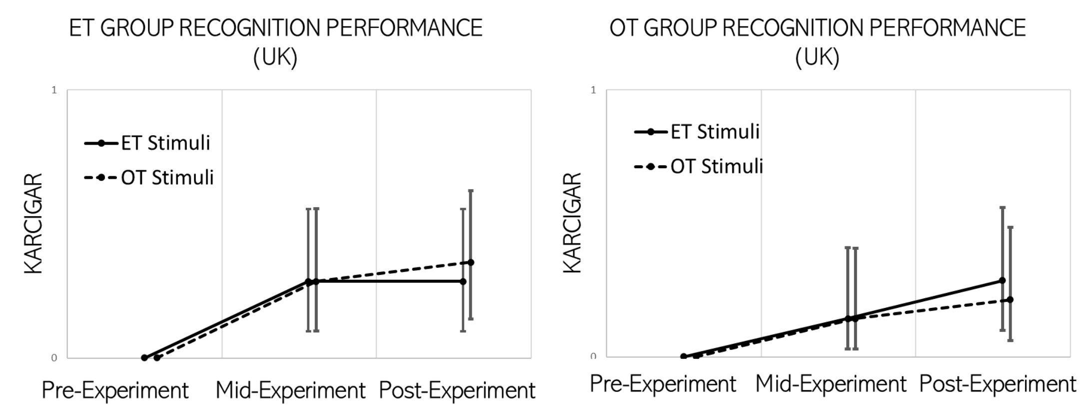


Figure 5.5. Predicted Karcigar makam verbal identification probability separated by time (pre vs mid vs post experiment), ear training type and stimulus temperament system in the UK with 95 % CI.

Subsequently, I employed the same statistical procedure for the verbal identification performance of the Huzzam makam (figure 5.6). Since the Huzzam makam instructions started on the third week of ear training classes, as expected, the verbal identification performance of the Huzzam makam was zero from pre to mid measurements. According to the results, only the experimental time factor (F (2,156)= 27.56, $p<.01$) was significant, indicating that the verbal identification performance of the Huzzam makam improved after taking temperament-based ear training classes. However, neither the temperament system and ear training nor the interactions of these factors influenced the verbal identification performance in Huzzam makam (for the full table, see Appendix L).

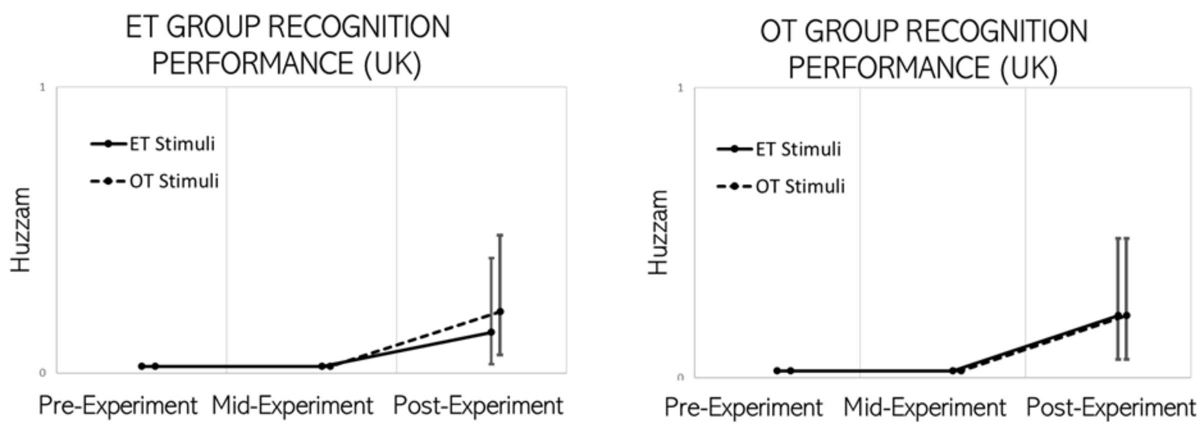


Figure 5.6. Predicted Huzzam makam verbal identification probability separated by time (pre vs mid and vs post experiment), ear training type and stimulus temperament system in the UK with 95 CI.

5.3.2.2 TR

I re-applied all analysis processes for TR participants' verbal identification performance to understand whether the identification performance of makams might depend on the temperament systems employed in ear training and listening experiments and whether passive cultural and unintentional familiarity might influence the verbal identification performance of these makams.

Figure 5.7 shows the verbal identification performance of TR participants across three measurement points. The model results for the Karcigar makam showed that only the time factor (F (2,25)=144, $p<.01$) was significant, indicating that the verbal identification performance improved after participating in an ear training class in the Karcigar makam. However, neither the temperament system and ear training nor the interactions of these factors influenced the verbal identification performance of the Karcigar makam (for the full table, see Appendix M). Furthermore, the country comparison model revealed that the verbal identification performance did not differ according to country.

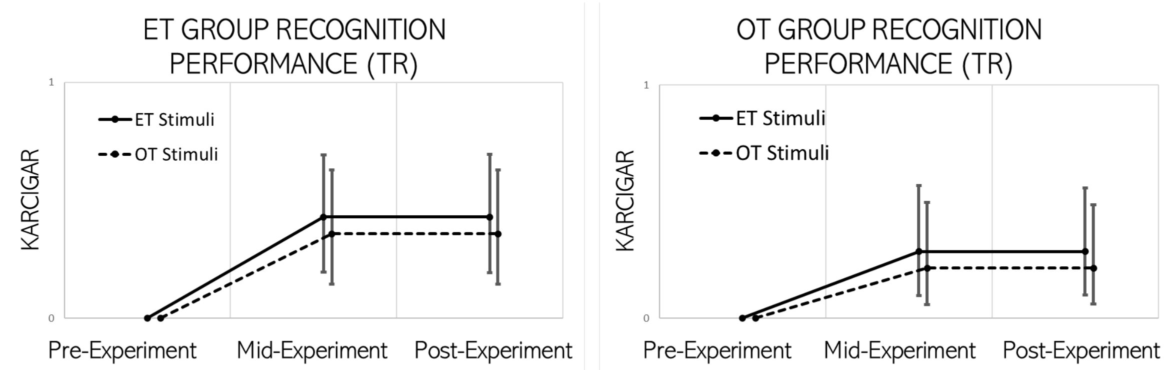


Figure 5.7. Predicted Karcigar makam verbal identification probability separated by time (pre vs mid and vs post experiment), ear training type and stimulus temperament system in TR with 95% CI.

Figure 5.8 shows the verbal identification performance of TR participants for the Huzzam makam. The analysis of the Huzzam makam showed that only the time main factor was significant, indicating that generally, the verbal identification performance improved after participating in ear training classes. However, as is the case with the previous verbal identification results, neither the temperament system nor its interactions with other main factors influenced the verbal identification performance (for the full table, see Appendix N). Also, verbal identification performance did not differ according to countries.

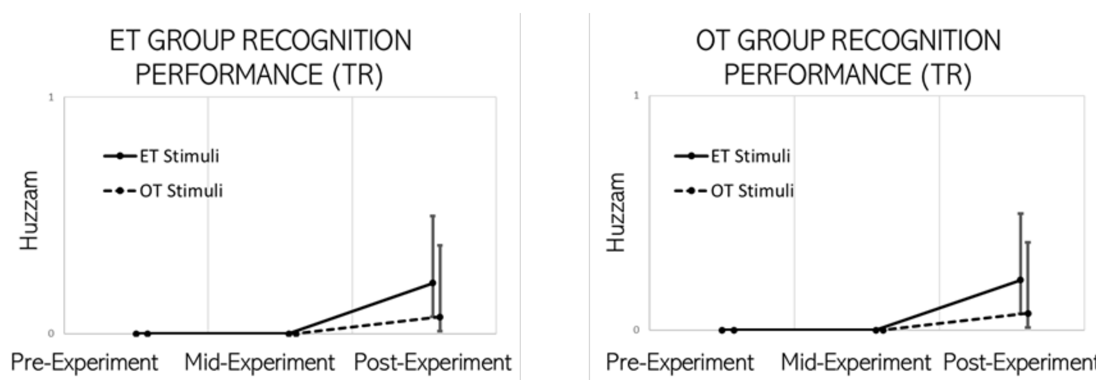


Figure 5.8. Predicted Huzzam makam verbal identification probability separated by time (pre vs mid and vs post experiment), ear training type and stimulus temperament system in the TR with 95% CI.

5.3.2.3 Summary of the Effect of Ear Training on Verbal Identification Performance of Karcigar and Huzzam Makams

The analyses on verbal identification performance of Karcigar and Huzzam makams have shown that although the identification performance of both makams increased, this increase was not a function of temperament systems or the ear-training course.

5.3.3 Effect of Ear Training on Emotional Experience of Karcigar Makam

As I noticed a change in participants' ability to recognise and identify the previously unfamiliar Karcigar and Huzzam makams, I then subsequently tested whether the ear training leads to any associated changes in their emotional experience of these makams. I first employed Hierarchical Linear models for each of the three second-order GEMS score means, using data for the Karcigar Makam. Here, I excluded other makams from the model approach as the only potential hypothesis was for the Karcigar makam. As fixed effects, I entered time (pre, mid, post), ear training course (OT, ET), temperament system (ET, OT) and instrumentation (oud, piano, kanun) as main factors and also the interactions of these main factors. In order to understand the differences between countries, I entered the country main factor (UK, TR) and its interactions into the full model. As applied in the pre-experiment model, predictors of best fit were obtained by the backwards-model approach. All estimations were based on compound symmetry covariance structure which produced the best AIC fit indices.

All results were presented as a section according to GEMS-25 second-order emotion factors (sublimity, vitality, unease). In every subsection, I presented first the UK participants' GEMS-25 second-order means and, after that, the TR participants' means. Subsequently, I presented the country-wise differences. In order to understand whether having a direct or indirect syntactic exposure might affect the emotional experience of Karcigar and Huzzam makam, I separated and classified results as pre-to-mid and mid-to-post periods.

5.3.3.1 Sublimity

Figure 5.9 presents the mean intensity of sublimity means in both countries separated by temperament stimuli and time. Even though Figure 5.9 (A) indicates various increases and decreases in UK participants' sublimity means in both groups, no experimental factor or interactions were statistically significant when modelling sublimity (for the full table, see Appendix O).

I employed another hierarchical model for TR participants' sublimity means to understand whether temperament-based ear training classes could change their previous emotional experience and if these experiences might differ cross-culturally due to TR participants' potential cultural passive exposure.

Figure 5.9 (B) shows TR participants' sublimity means in the Karcigar makam from pre- to post-experiment. Accordingly, the analysis for between pre- to mid- means revealed that the interaction between time and temperament system (F (1,73) =20.07, p<.001) was statistically significant, indicating that temperament stimuli means changed from pre- to mid-measurement. Based on figure 5.9 (B), OT group's sublimity means in OT decreased, and the means in ET temperament stimuli increased from pre-to-mid measurements. On the other hand, while ET group's sublimity means in OT stimuli remained stable, the sublimity means in ET stimuli increased from pre-to-mid measurements. A post-hoc analysis using Sidak correction showed that the OT group's decreased means in OT stimuli (pre-experiment: M=1.86 SD= .20, mid experiment: M=1.19 SD= .07; p<.001) was statistically significant. Additionally, ET group's increased means in ET temperament stimuli was also significant (pre-experiment: M=1.21 SD= .05, mid-experiment: M=1.50 SD= .10; p<.001). On the other hand, the analysis did not reveal any significant effect of other main factors or the interaction between the main factors (for the full table, see Appendix P).

Another model was estimated by adding the country as an independent variable into the model. According to the model, country main factor (F (1,52) =24.13, p<.001) and the interaction between country, time and temperament system were statistically significant (F (1,52) =24.13, p<.001), indicating that sublimity means changed according to the country and the means of temperament system changed over time according to the country. In parallel to these findings, the Karcigar makam was rated as more sublime by the UK participants (M=2.11 SD= .09) when compared to the TR participants (M=1.31 SD= .09). Also, the post-hoc test for significant interaction between country, time and temperament system revealed that the statistical significance originated from TR participants' increased sublimity means in ET temperament stimuli between pre-to-mid measurement (pre-experiment: M=1.46 SD =.13, mid-experiment: M=1.71 SD= .13; *t* (212) =2.02, *p*<.05). No other main factors or interactions were significant (for the full table, see Appendix Q).

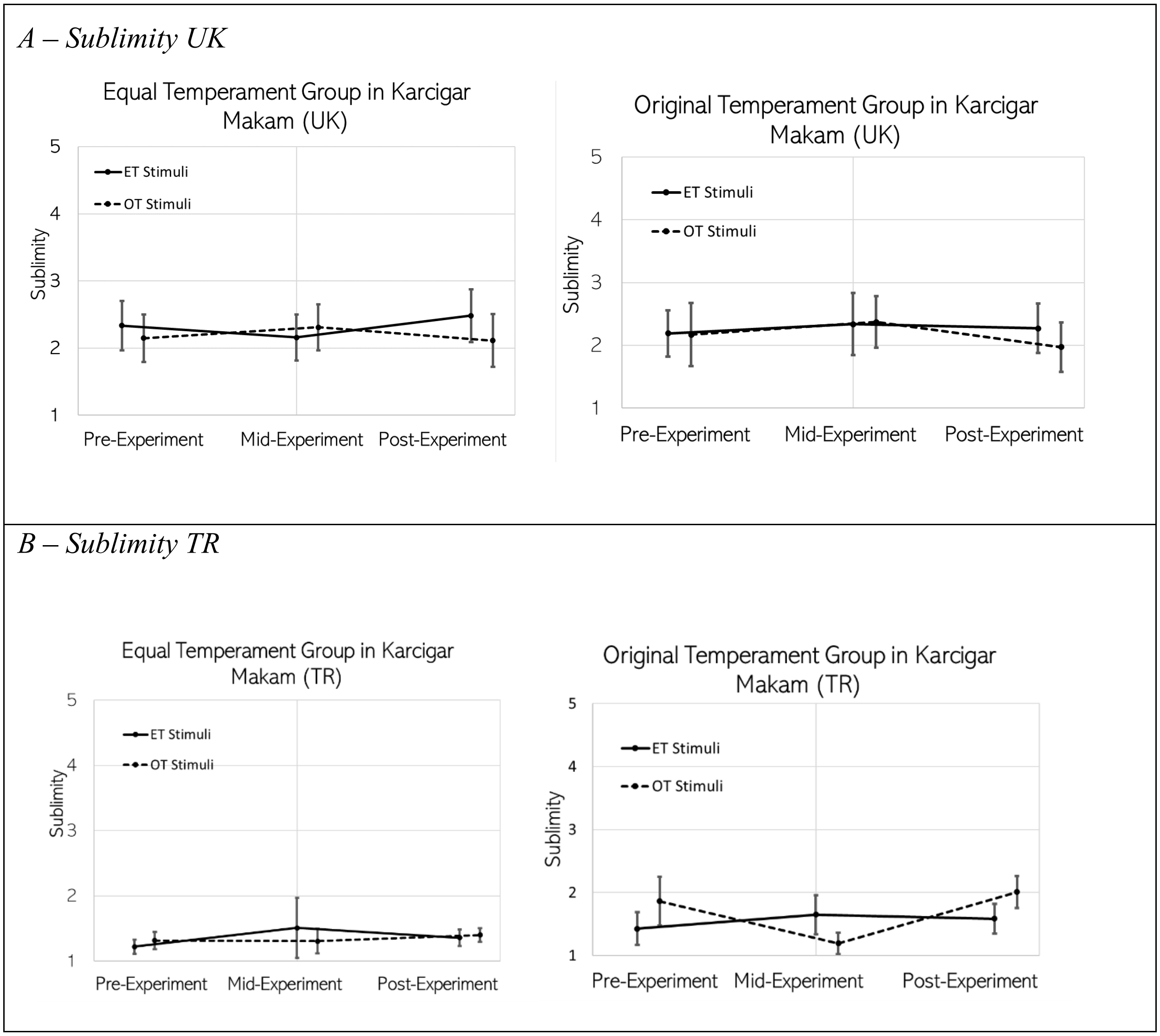


Figure 5.9. Error-bar graph of fixed effects estimated for sublimity GEMS factor for Karcigar makam in both countries separated by time (pre vs mid vs post experiment), ear training type and stimulus temperament system with 95% CI.

I subsequently tested whether having no direct syntactic exposure to the Karcigar makam might influence UK participants' sublimity means. Here, I employed Hierarchical Linear models only for the mid- to post-measurement period. According to the results, temperament system ($F_{(1,81)} = 4.56$, $p<.05$) main factor and the interaction between time and temperament system ($F_{(1,81)} = 3.79$, $p<.05$) influenced the sublimity means of the UK participants. Figure 5.9 (A) shows that while the OT group's sublimity means in OT stimuli decreased from mid to post-experiment, means in ET stimuli remained stable. On the other hand, while ET group's sublimity means in OT stimuli decreased, means in ET stimuli increased between mid to post-experiment. Based on F test results, the UK participants rated the ET stimuli (M= 2.36 SD= .13) as more sublime than OT stimuli (M=2.19 SD= .13), and this difference was statistically significant ($t_{(104)} = 2.14$, $p<.05$). Furthermore, the post-hoc test for significant interaction between time and temperament system also revealed that even though OT group participants rated both stimuli on the same level in mid-measurement (ET stimuli: M=2.34 SD= .14, OT stimuli: M=2.34 SD= .14), in post-experiment, UK participants rated ET stimuli (M=2.04, SD= .14) as more sublime than OT stimuli (M=2.38, SD= .14) indicating that without having a direct exposure, participants experienced the familiar temperament system as more sublime when compared with unfamiliar OT ($t_{(102)} = 2.40$, $p<.05$). No other main factor or interaction was significant when modelling this period (for the full table, see Appendix R).

I employed another model for the same period if having no direct syntactic exposure to the Karcigar makam could influence Turkish participants' means and compare whether these means could differ cross-culturally. According to the model results, the temperament system main factor ($F_{(1,75.55)} = 10.97$, $p<.05$) influenced the sublimity means of the Karcigar makam. In line with this result, TR participants experienced more sublimity in OT system than ET system ($t_{(102)} = 3.31$, $p<.001$). Furthermore, the interactions between time and ear training ($F_{(1,56.55)} = 7.20$, $p<.001$) and time and temperament system ($F_{(1,56.95)} = 6.73$, $p<.01$) were also statistically significant. Figure 5.9 (B) indicates that, while OT group's means in OT stimuli increased from mid to post-experiment, the means in ET stimuli remained stable, indicating that TR participants experienced OT stimuli as more sublime than ET stimuli. This result might be evaluated as an accommodation of the OT system by Turkish participants.

Additionally, while the ET group's means in ET temperament stimuli decreased over time, the means in OT stimuli remained stable. Post-hoc analyses using Sidak correction revealed that the OT group's rating increase from mid (M=1.28 SD= .05) to post (M=1.43 SD= .08) experiment (t (102) =2.77, p<.001) in OT stimuli was statistically significant. No other main factors or interactions were significant when modelling sublimity (for the full table, see Appendix S).

The hierarchical model, including the country variable, also revealed that sublimity means were different in accordance with countries (F (1,52) =26.69, p<.001). Furthermore, merged participants means showed that in general, the temperament system (F (1,160) =8.54, p<.001) main factor and the interaction between the country, time and temperament system (F (1,160)=5.33, p<.05) significantly influenced the sublimity experience of participants. Accordingly, the UK participants (M=2.28, SD=.10) rated the Karcigar makam as more sublime than Turkish participants (TR:1.55, SD=.10) as in pre- to mid-measurement. Furthermore, a post-hoc test showed that in general, the ET system (M=2.00, SD=.08) stimuli influenced more sublimity than the OT system (M:1.83, SD=.08). This indicates that without syntax exposure to the Karcigar makam, participants experienced more sublimity in their formally familiar temperament system. The post-hoc result for the country, time and temperament system also revealed that the significance originating from the UK ET group participants decreased the score from the pre- to mid- and increased the score from mid- to post-measurement in ET. No other main factors or interactions were significant (for the full table, see Appendix T).

5.3.3.2 Vitality

Figure 5.10 (A) shows the vitality means across three measurement points by the UK participants. According to the results, the time and ear training interaction (F (1,78) =5.89, p<.05) significantly influenced the vitality means between pre-to-mid period, indicating that the experience of the UK participants changed over time according to the training course taken. In line with this result, OT group's increased vitality means in the first two weeks was statistically significant. This indication was also confirmed by post-hoc test using Sidak correction (pre-experiment: M=2.05 SD= .21, mid-experiment: M= 2.57 SD= 0.21, t (104)=1.86, p<.05). No other main factor or interaction was significant when modelling this period (for the full table, see Appendix U).

Even though Figure 5.10 (B) shows various changes for TR participants' vitality means from pre- to mid-measurements in both ear training groups, neither main factors nor interactions were statistically significant, indicating that vitality means were not influenced by our experimental conditions (for the full table see Appendix V).

I then employed another model, including the country as main factor. According to the model, the vitality means differed according to the country main factor (F (1,53) =10.38, *p*<.001). Furthermore, the interaction between time and ear training course (F (1,156) =5.58, *p*<.05) was statistically significant (for the full table, see Appendix W). As is the case with sublimity means, the UK participants (M=2.33 SD= .10) rated the Karcigar makam as more vital than the TR participants did (M=1.88 SD= .10). Additionally, the significance in time and ear training interaction originated from the general decrease in ET groups' means from pre- (M=2.25 SD= .12) to mid-measurement (M=1.90 SD= .12; *t* (212) =2.34, *p*<.05). Another model was estimated for vitality means of UK participants from the mid- to post-measurement. Figure 5.10 (A) shows that the vitality means changed over time according to ear training courses, which also indicated a significant interaction between time and ear training course (F (1,76) =6.06, *p*<.05). Accordingly, while the vitality means of the OT group decreased in both temperament stimuli from mid- to post-experiment, the ET group's vitality means increased in ET stimuli but remained stable in OT stimuli. Based on this result, I employed a post-hoc test using Sidak correction. The result showed that the decrease in the OT group's means was statistically significant (Mid Experiment: M=2.53 SD= .2, Post Experiment: M=2.07 SD= .22; *t* (104) =1.88, *p*<.05). On the other hand, the analysis did not reveal any significant effect of temperament systems or interactions between temperament systems and ear training courses, indicating that the temperament system did not influence the experience of vitality in the Karcigar makam in this period (for the full table, see Appendix X).

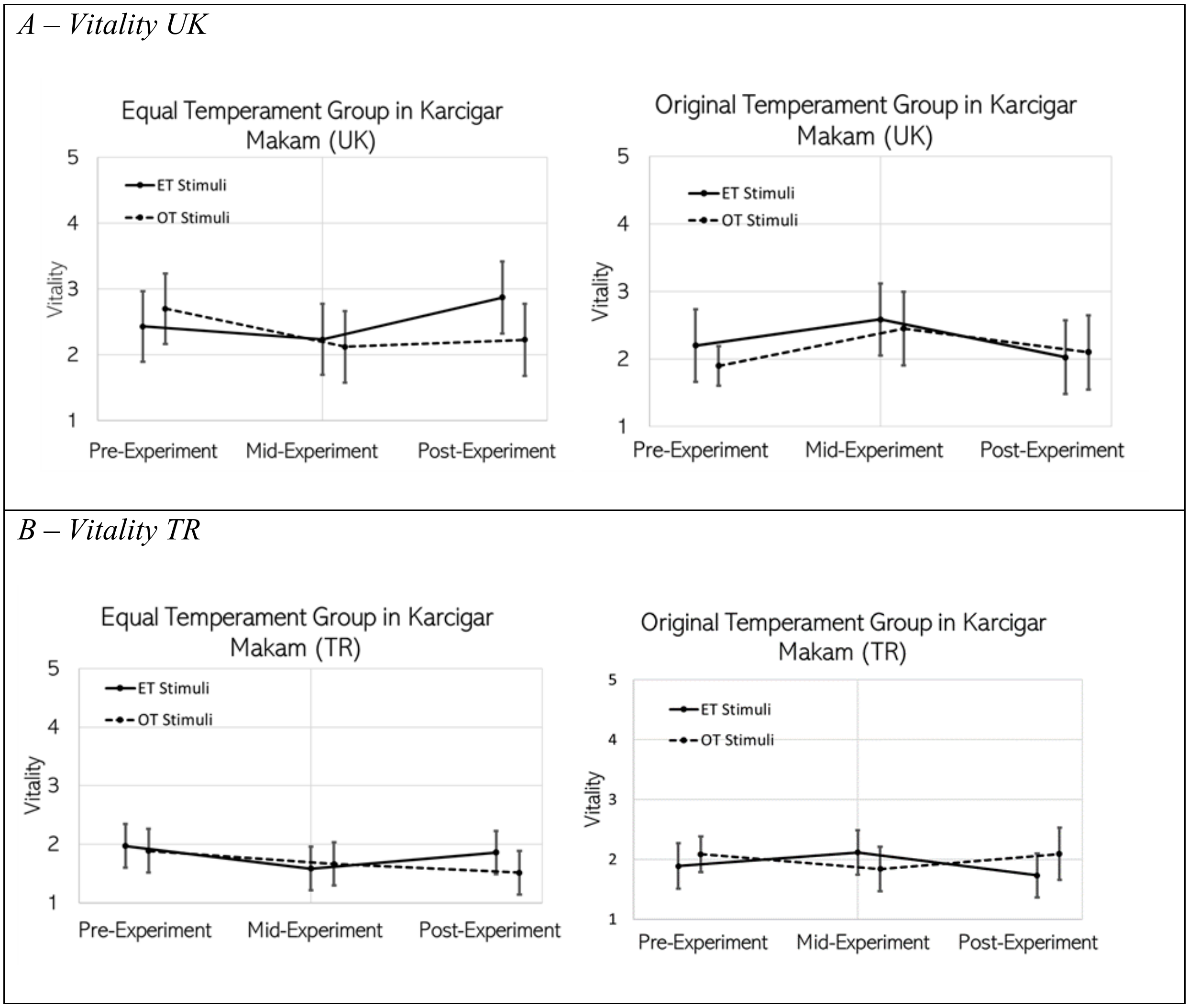


Figure 5.10. Error-bar graph of fixed effects estimated for vitality GEMS factor for Karcigar makam in both countries separated by time (pre vs mid vs post experiment), ear training type and stimulus temperament system with 95% CI.

I subsequently employed the same model for vitality means of TR participants from mid- to post-experiment. Accordingly, only the interaction between time, ear training course and temperament system (F (1,75) =5.52, *p*<.05) was statistically significant, indicating that the vitality means of TR participants in temperament systems changed over time according to ear training groups. To understand significant interactions behind the conditions, I employed a post-hoc test using Sidak correction. Even though figure 5.10 (B) shows the effect of the taken temperament-based ear training course while experiencing vitality in the Karcigar makam, only the decrease of ET temperament stimuli in the OT group (mid Experiment: M=2.13 SD=.18, post Experiment: M=1.73 SD= .19; *p*<.05) was statistically significant (*t* (104) =-1.78, *p*<.05). On the other hand, the analysis did not reveal any significant effect of other main factors or these factors' interactions (for the full table, see Appendix Y).

The estimated hierarchical model for understanding the differences between countries also showed that vitality means differed in accordance with countries (F (1,52) =11.76, *p*<.001). According to the result, the UK participants (M=2.33, SD=.11) rated the Karcigar makam as more vital than the TR participants did (M=1.79, SD=.11, *p*<.001) as in pre- to mid-measurement period. Fixed effect results also revealed that the interaction between time and ear training (F (1,52) =5.63, *p*<.05) was significant, indicating that, in general, the means of ear training groups changed over time. According to the post-hoc results, the means of OT group in OT stimuli decreased over time (mid experiment: M=2.24 SD= .13, post experiment: M=1.98 SD= .13; (*t* (208) =-1.88, *p*<.05). Additionally, the four-way interaction between the country, time, ear training and temperament system was also significant (F (1,156) =3.77, *p*<.05).

On the other hand, the analysis did not reveal any significant effect of the temperament systems factor or other interactions of the temperament system and ear training factors (for the full table, see Appendix Z).

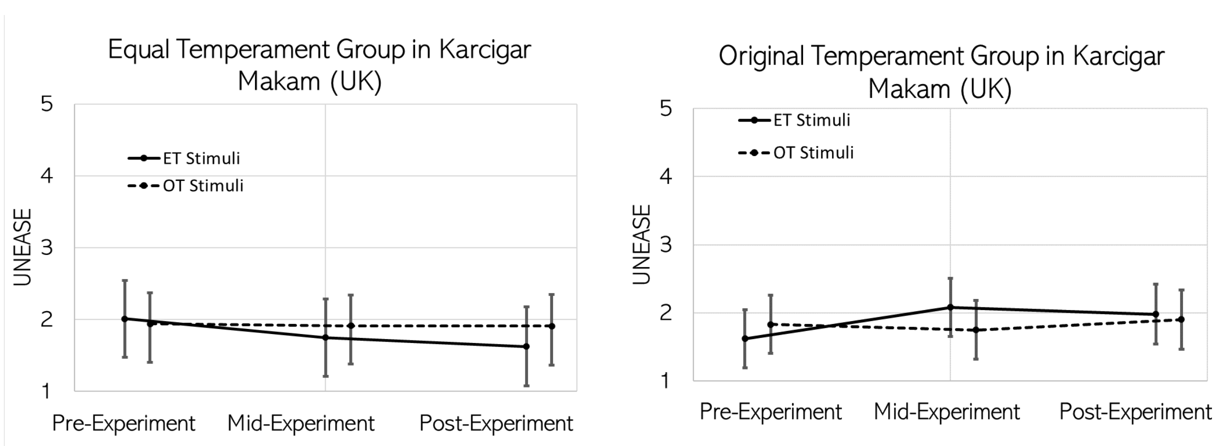
5.3.3.3 Unease

I employed another model for the unease (sadness and tension) experience of the Karcigar makam in the UK for pre to mid means. Figure 5.11 (A) shows UK participants' unease means across three measurement points. According to the results, the interaction between time, ear training course and temperament system was statistically significant (F (1,76) =6.68, *p*<.05). Although figure 5.11 (A) shows that ET group unease means in both temperament stimuli type decreased, the decrease in ET stimuli was remarkably higher than OT stimuli. On the other hand, while the unease means of the OT group in OT stimuli decreased, the means in ET stimuli increased from pre to mid means. A post-hoc comparison using Sidak correction revealed that the increase in means of OT group in ET temperament stimuli from pre (M=1.62 SD= .21) to mid (M= 2.08 SD= .21) experiment was statistically significant (*t* (104) =-2.49, *p*<.05). This result might also be interpreted as an influence of a temperament-based ear training course taken on the uneasy experience of the Karcigar makam. On the other hand, the analysis did not reveal any significant effect of the main factors or the interactions between these factors (for the full table, see Appendix AA).

Subsequently, I analysed the unease means of TR participants in the Karcigar makam between pre to mid experiment. Even though figure 5.11 (B) shows various increases and decreases in both ear training groups, according to the model results, neither the main factors nor its interactions influenced the unease means of the Karcigar makam (for the full table, see Appendix AB).

Afterwards, I employed another model that includes the country main factor as an independent variable. According to the model, the country main factor was statistically significant (F (1,52) =11.93, *p*<.001), indicating that uneasiness means were different in accordance with the countries. Based on this result, TR participants (M= 1.36 SD= .10) experienced less uneasiness in the Karcigar makam than the UK participants did (M= 1.89 SD= .10). The estimated model also revealed that the interaction between the country, time, ear training and temperament system was also significant. On the other hand, the analysis did not reveal any significant effect of other main factors or these factors' interactions (for the full table, see Appendix AC).

A – Unease UK



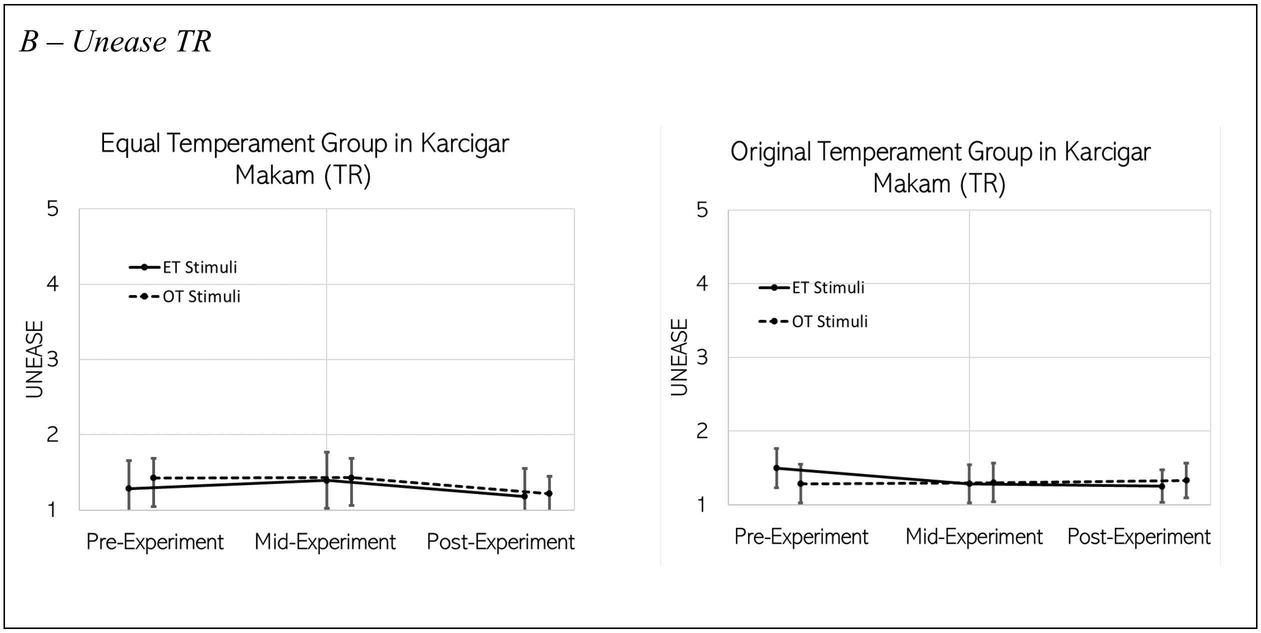


Figure 5.11. Error-bar graph of fixed effects estimated for unease GEMS factor for Karcigar makam in both countries separated by time (pre vs mid vs post-experiment), ear training type and stimulus temperament system with 95% CI.

As is the case for other GEMS second-order means, I analysed the unease means of UK participants between mid to post experiment to understand whether having no exposure to the Karcigar makam might influence the emotional experience of uneasiness. Accordingly, only the interaction between ear training course and temperament system was significant ($F(1,76) = 5.05$, $p < .05$), indicating that the means of temperament stimuli types were different in accordance with the ear training group. As can be seen from figure 5.11 (A), I observed a constant decrease of unease means in ET stimuli but a stable trend in OT temperament stimuli for the UK-ET group. This continuous experience might be interpreted as an advantage of a familiar temperament system accompanying a familiar temperament-based ear training course. In the absence of syntactic exposure, the OT group's uneasy experience in OT stimuli was increased but also slightly decreased in ET stimuli. Nevertheless, the uneasy experience of OT stimuli was lower than ET stimuli. This could also be interpreted as a lasting effect of the temperament-based ear training course in view of OT group's decreased experience in OT stimuli in the previous period (for the full table, see Appendix AD).

Figure 5.11 (B) shows the unease means in the Karcigar makam by Turkish participants. Even though there were various decreases and increases in both groups, the model did not reveal any significant differences between temperament systems and ear training courses or interactions of these conditions (for the full table, see Appendix AE).

The model for understanding the differences between countries showed that unease means were different in accordance with countries ($F(1,53) = 16.49$, $p < .001$). Accordingly, as was the case with pre to mid measurements, TR participants ($M = 1.29$ $SD = .10$) experienced less unease in the Karcigar makam than the UK participants did ($M = 1.84$ $SD = .10$). This finding might also be interpreted as a possible indication of passive cultural exposure effect on the uneasy emotions while listening to Karcigar makam. On the other hand, the analysis did not reveal any significant effect of other main factors or these factors' interactions (for the full table, see Appendix AF).

5.3.3.4 The Summary of Effect of Ear Training on Emotional Experience of Karcigar from Pre to Mid Measurement

As I noticed a change in participants' ability to identify the previously unfamiliar Karcigar and Huzzam makam, I then tested whether the ear training leads to any change in their emotional experience of the Karcigar makam and whether these are congruent with taken temperament-based ear training courses. To understand the temperament system effect and due to employing a 'from easy to difficult' teaching method, the Karcigar makam's features were introduced to participants in the first two weeks. Following that, in the last two weeks, the participants learned the Huzzam makam features. Here, I aimed to understand if temperament systems are a parent system of any syntactic construction, and if it can be learned by statistical exposure; despite not having exposure to the Karcigar makam's syntax structures in the second half of the exposure phase, participants' emotional experience should have been congruent with the employed temperament system in the ear training courses. In this way, I would have had a chance to test whether these emotional responses were either a schematic or a veridical memory outcome in the case of the congruency effect.

The analysis of sublimity means by the UK participants showed that neither temperament systems and ear training main factors nor interactions of these main factors influenced the sublimity experience. On the other hand, the statistical analysis of TR participants revealed that in both ear training groups, the sublimity means of the Karcigar makam increased from pre to mid experiments in the ET system. Also, the comparison between countries showed that the UK participants continued to experience more sublime emotions than the TR participants did. No other main factors or interactions were significant in sublimity second-order score analysis.

The vitality results of the UK participants showed that although the vitality means of the UK-OT group increased between pre to mid measurements, this was not a function of the temperament system main factor (indicated only by statistically significant time and ear training interaction). On the other hand, TR participants' vitality means in the Karcigar makam were not influenced by any experimental factors. Further analysis to understand the differences between countries revealed that the UK participants experienced more vitality in the Karcigar makam than the TR participants did. No other main factors or interactions were significant in sublimity analysis.

The uneasy experience analysis in the Karcigar makam revealed that the UK-OT ear training group's uneasy experience was congruent with the taken temperament system in ear training (indicated by a statistically significant interaction between time, ear training and temperament system). On the contrary, TR participants' uneasy experience in the Karcigar makam was not influenced by any experimental conditions. The country-wise analysis showed that TR participants continued to experience the Karcigar makam as inducing less unease (sadness and tension) than the UK participants. On the other hand, the analysis did not reveal any significant effect of other main factors or these factors' interactions.

5.3.3.5 The Effect of Ear Training on Emotional Experience of Karcigar from Mid to Post Measurement

To understand whether the observed temperament system effect in the UK-OT group was an outcome of schematic expectation or veridical expectation and whether the extended exposure time of temperament-based ear training courses might change the emotional experience of Karcigar makam, I analysed participants' GEMS-25 second-order means in the Karcigar makam.

The UK participants' analysis in sublimity means revealed that the UK-OT group's sublimity experience in Karcigar makam decreased in OT stimuli but increased in the familiar ET system (indicated by a statistically significant interaction between time and temperament system). In contrast with the UK finding, the TR-OT ear training group's previously increased sublimity experience decreased in ET stimuli but increased in OT stimuli. Further analysis to understand country-wise differences revealed that the UK participants continued to experience more sublimity in the Karcigar makam from mid to post experiments. Moreover, the statistical significance between country, time and temperament system showed that the increased sublimity means of ET temperament stimuli in the UK-ET group was statistically significant. No other main factors or interactions were significant when modelling this period.

The analysis of the vitality means in the UK revealed that while the UK-OT group's vitality experience in the Karcigar makam decreased in both temperament stimuli (indicated by a statistical significance in pairwise comparison), the experience of the UK-ET group increased between mid to post experiment. However, neither temperament system nor ear training influenced the vitality means. On the other hand, even though in both TR groups, the vitality means increased in accordance with the temperament system employed in the ear training courses, only the decreased experience of the TR-ET group in OT stimuli was statistically significant. The country-wise analysis also showed that the UK participants continued to experience the Karcigar makam as more vital than the TR participants did. Moreover, overall the vitality means of the OT group decreased over time in both countries (indicated by a statistically significant interaction between time and ear training).

The analysis to understand the uneasy experience of the UK participants in this period showed that the UK-ET group's unease means decreased from mid to post experiment when compared to UK-OT group's means in the same period. In contrary to this result, the unease means of TR participants was not influenced by any experimental conditions. Further analysis to understand the differences between countries showed that, overall, TR participants continued to experience less unease (sadness and tension) in the Karcigar makam than the UK participants.

5.3.4 Effect of Ear Training on Emotional Experience of Huzzam Makam

Participants received Huzzam makam instructions in ear training classes after the second week of the four-week ear training period. From a music theoretic perspective, Huzzam makam shares a similar structure with Karcigar makam (while the Karcigar makam consists of a Hicaz pentachord on top of Ussak tetrachord, Huzzam makam uses a Hicaz tetrachord on top of the Huzzam pentachord) but differs in terms of syntactic construction, extension and used pitch positions (for details see Section 3.4.3). In order to understand whether having a direct or indirect syntactic exposure might affect the emotional experience of the Huzzam makam, and due to adopting a 'from easy to difficult' teaching method, participants received Huzzam makam instructions in the third week.

I again employed Hierarchical Linear models for each of the three second-order GEMS score means, using data for the Huzzam Makam. Here, we excluded other makams from the model approach due to the only potential hypothesis of change being for Huzzam makam. Accordingly, I entered time (pre, mid, post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions. I also employed other linear models by including the country main factor (UK, TR) into the previous full model with the other main factors to understand the differences between countries.

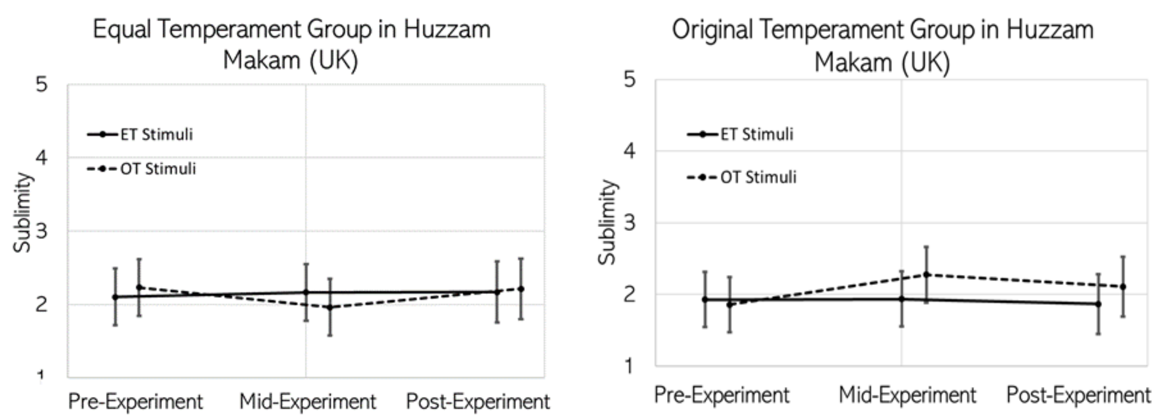
In every subsection, I firstly presented the UK participants' means and, after that, the TR participants' means. Subsequently, I presented the results of the country comparison.

5.3.4.1 Sublimity

Figure 5.12 (A) shows the sublimity means of ear training groups in the UK across three time points. According to the graphs, while OT group's sublimity means in OT stimuli increased, the means in ET stimuli remained stable from pre to mid measurement. On the other hand, while the UK-ET group's sublimity means decreased in OT stimuli, the sublimity means in ET stimuli increased. The estimated model for the pre to mid period revealed that the interaction between time, ear training course and temperament system was statistically significant ($F(1,78) = 4.61$, $p < .05$). The analysis did not reveal any significant effect of other main factors or these factors' interactions (for the full table, see Appendix AG). Accordingly, post-hoc tests revealed that the significance between time (pre to mid), ear training course and temperament system originated from increased OT temperament stimuli means in the OT group (pre-experiment: M=1.90 SD= .19, mid-experiment: M=2.22 SD= .19; $t(104) = 2.45$, $p < .05$). This indicates that the Huzzam makam was experienced as more sublime by the OT ear training group as a possible exposure effect of the OT-based ear training course. On the other hand, the decreased sublimity means of the ET group in OT stimuli could also be interpreted as an effect of the temperament-based ear training course, and the model did not reveal any statistical significance.

I employed the same statistical procedures to understand TR participants' emotional experience in Huzzam makam, and Figure 5.12 (B) shows TR participants' sublimity means across three measurement points. The sublimity experience analysis of TR participants showed that the ear training main factor was statistically significant, indicating that the sublimity experience of ear training groups differed in accordance with the taken ear training course. Accordingly, the OT group (M=1.9, SD= .11) experienced the Huzzam makam as more sublime than the ET group did (M=1.58, SD=.11). On the other hand, the analysis did not reveal any significant effect of temperament systems or the interaction between the temperament system and ear training courses (for the full table, see Appendix AH).

A – Sublimity UK



B – Sublimity TR

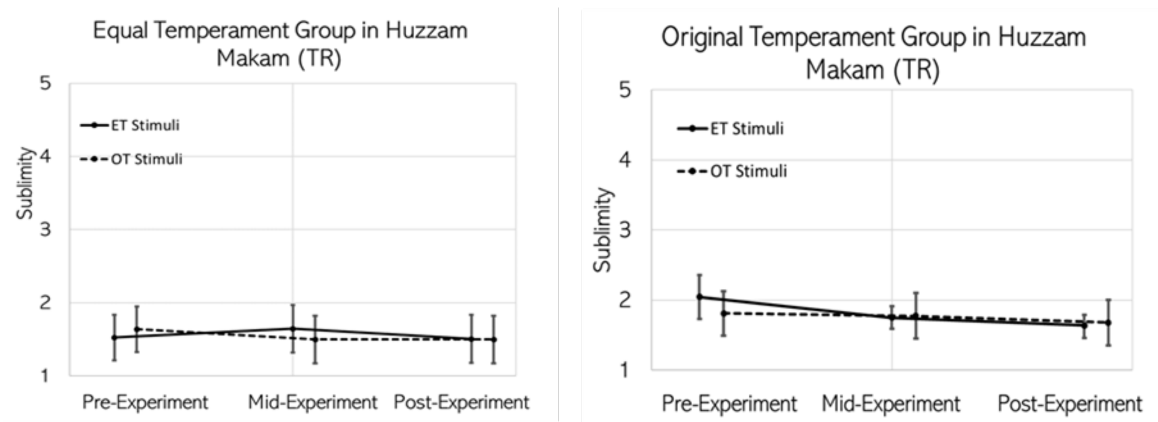


Figure 5.12. Error-bar graph of fixed effects estimated for sublimity GEMS factor for Huzzam makam in both countries separated by time (pre vs mid vs post experiment), ear training type and stimulus temperament system with 95% CI.

Subsequently, I employed another model to understand whether the experience of the Huzzam makam differed in accordance with the countries between pre to mid measurements. According to the results, only the country main factor was significant, indicating that the sublimity means of the Huzzam makam differed in accordance with countries. As was the case with the Karcigar Makam, the UK participants (M=2.09 SD= .11) experienced more sublimity than the Turkish participants (M=1.67 SD= .11) when listening to the Huzzam makam. No other main factors and interactions were significant (for the full table, see Appendix AI).

I also wanted to see whether the previously rated emotional experiences of the Huzzam makam might change by having a syntactic exposure to Huzzam makam. For this reason, I employed hierarchical models for mid to post measurement. Here, I entered time (pre, mid, post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions but only for the mid-to-post rating period. Since instrumentation did not influence the emotional experience of the Huzzam makam, I excluded the timbre main factor from the model.

According to Figure 5.12 (A), the UK-OT group participants experienced a relatively more sublime experience in OT stimuli when compared with ET stimuli. Even though this indicates a possible temperament-based ear training effect on the sublimity experience of Huzzam makam, this experience was not observed in the UK-ET group. Accordingly, while the UK-ET group's previously decreased sublimity experience in OT stimuli increased from mid to post measurement, the means in ET temperament stimuli remained stable. These observations were also indicated by a statistically significant interaction between an ear training course and temperament system (F (1,80) =5.74, $p<.05$). A post-hoc analysis revealed that the sublimity experience of the OT group in OT stimuli was statistically significant (OT stimuli: M=.2.18 SD= .19; t (104) =1.92, $p<.05$). No other main factors and interactions were significant (for the full table, see Appendix AJ).

I then applied the same statistical procedure to the sublimity means of TR participants in order to understand if a direct syntactic exposure through ear training courses could change the emotional experience of the Huzzam makam. The linear model results for TR participants' sublimity means revealed that neither the temperament system main factor nor the interactions of temperament system and ear training influenced TR participants' sublimity means in the Huzzam makam (for the full table see Appendix AK).

I employed Hierarchical Linear models, including the country as an independent variable. The results showed that the sublimity experience of the Huzzam makam differed in accordance with countries (F (1,10) =3.70, $p<.01$). Furthermore, the interaction between country and temperament system was statistically significant, indicating that temperament stimuli means also differed in accordance with countries (for the full table, see Appendix AL). As is the case with the previous period's sublimity experience, the UK participants (M=2.08 SD= .11) experienced more sublimity in the Huzzam makam than the TR participants did (M=1.67 SD= .11). Post-hoc result for the interaction of country and temperament system revealed that UK participants (OT:M=2.14 SD= .12; ET: M=2.03 SD= .12) experienced more sublimity than the TR participants did (OT:M=1.62 SD= .12; ET: M=1.72 SD= .12) in both temperament systems (OT: t (208) =3.02, $p<.001$; ET: t (206) =1.83, $p<.05$).

5.3.4.2 Vitality

Subsequently, I tested how temperament-based ear training class participation could influence the UK and TR participants' vitality means in the Huzzam makam. Here, I entered time (pre-to-mid; mid-to-post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions but only for the mid-to-post rating period. As is the case with previous sublimity result presentations, in order to understand whether having a direct or indirect syntactic exposure might affect the vitality experience of the Huzzam makam, I separated and introduced results as pre-to-mid and mid-to-post periods.

The model results between the pre-to-mid measurement period showed that only the interaction between time and ear training ($F(1,31) = 4.61$, $p < .001$) was statistically significant, indicating that the experience of vitality in the Huzzam makam differed in accordance with ear training courses from pre-to-mid measurements. The post-hoc result for time and ear training interaction showed that this significance originated from the increased vitality means of the OT group from pre ($M = 2.00$ $SD = .18$) to mid measurement ($M = 2.30$ $SD = .20$; $t(102) = 1.86$, $p < .05$). On the other hand, the analysis did not reveal any significant effect of temperament systems or interaction between temperament system and ear training courses (for the full table, see Appendix AM).

Figure 5.13 (B) shows the vitality means of TR participants across three measurement points. Accordingly, while the TR-OT group participants' vitality means in Huzzam makam increased in OT stimuli but decreased in ET stimuli, TR-ET group participants' vitality experience in ET stimuli remained stable. Furthermore, the means in OT stimuli decreased from pre to mid measurements. These changes were also confirmed by statistically significant interactions between ear training course and temperament system ($F(1,42) = 4.36$, $p < .05$) and between time, ear training course and temperament system ($F(1,37) = 7.82$, $p < .01$) in the model. The post-hoc results for the interaction between ear training course and temperament systems revealed that the vitality experience in OT stimuli ($M = 1.96$, $SD = .20$) was higher than ET stimuli ($M = 1.61$, $SD = .08$) in the OT group ($t(104) = 1.90$, $p < .05$). The post-hoc results for the interaction between time, ear training course and temperament systems revealed that the OT group's increased vitality means in OT stimuli was statistically significant (pre-experiment: $M = .1.67$ $SD = .14$, mid-experiment: $M = 2.32$ $SD = .36$; $t(104) = 2.74$, $p < .001$). This indicates that the OT group participants' vitality experience was influenced by the temperament system that was taught in the ear training course. Furthermore, the decreased vitality means of the ET group in OT stimuli (pre-experiment: M=.1.76 SD= .15, mid-experiment: M=1.39 SD= .15; t (104) =-1.84, $p<.05$) was also statistically significant, which might also be interpreted as a temperament-based ear training class effect.

On the other hand, no other main factors or interactions were significant (for the full table, see Appendix AN).

As is the case with previous models, I estimated another linear model to understand the differences between countries. Accordingly, only the country main factor was significant (F (1,53) =8.02, $p<.001$), indicating that vitality means differed in accordance with the country. According to the result, the UK participants (M=2.44 SD= .14) experienced more vitality than the TR participants did (M=1.87 SD= .14) in the Huzzam makam. No other main factors or interactions were significant (for the full table, see Appendix AO).

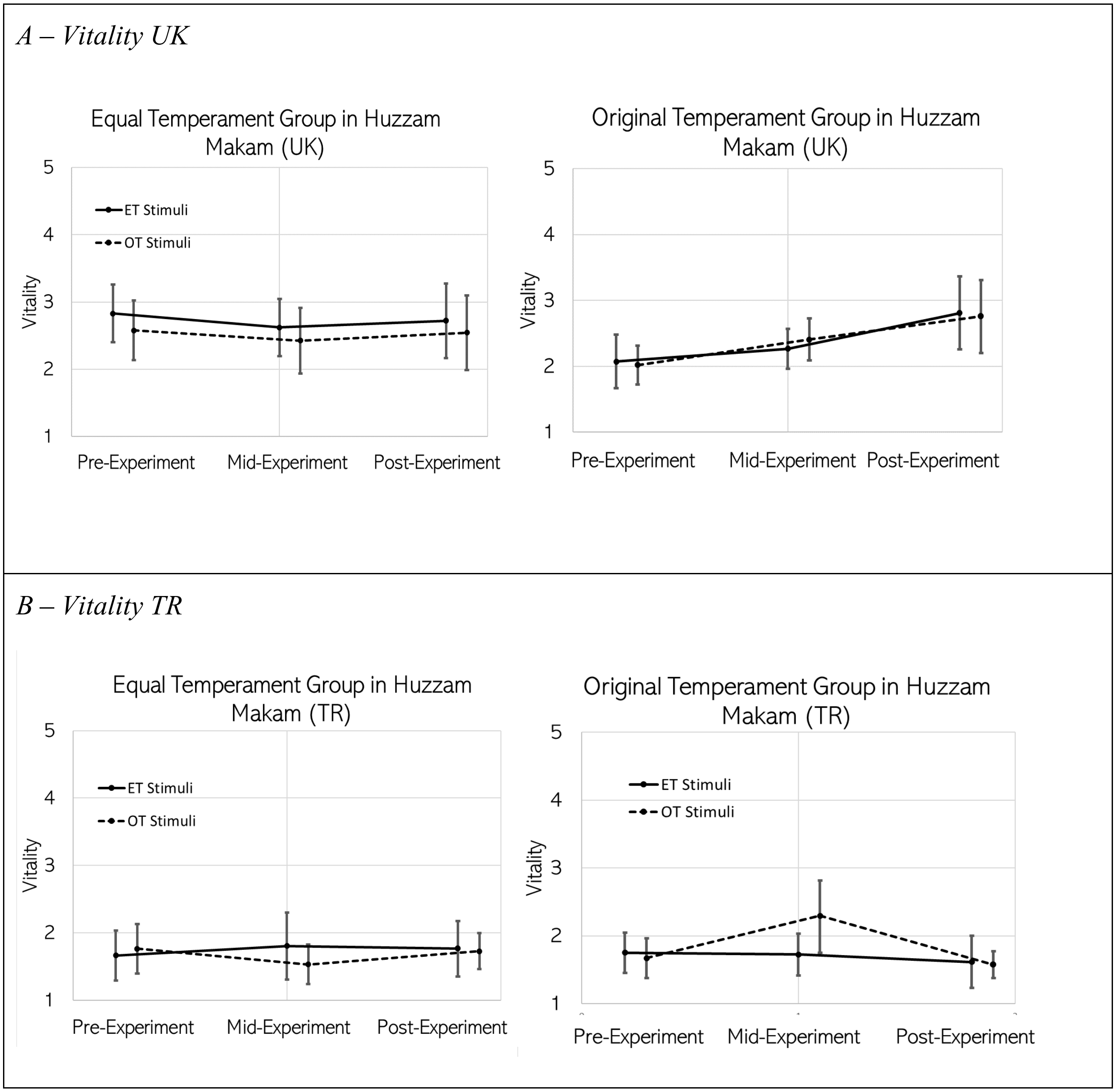


Figure 5.13. Error-bar graph of fixed effects estimated for vitality GEMS factor for Huzzam makam in both countries separated by time (pre vs mid vs post experiment), ear training type and stimulus temperament system with 95% CI.

Subsequently, I employed another model to understand if having direct syntactic exposure to the Huzzam makam could influence both countries' vitality means. Here, I again entered time (pre, mid, post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions but only for the mid-to-post rating period. Since the timbre factor did not influence the emotional experience of the Huzzam makam, it was excluded from all models.

According to the model results, the vitality experience of UK participants was influenced only by the time factor (F (1,81) =3.85, p<.05), indicating that vitality means changed over time. The result suggests that the vitality experience of the UK participants increased in general (Mid Experiment: M=.2.45 SD= .17, Post Experiment: M=2.71 SD= .17). On the other hand, all other factors and interactions were non-significant (for the full table, see Appendix AP).

Subsequently, I tested the vitality means of TR participants in the Huzzam makam (figure 5.13 B) between the mid and post measurement periods. The model results revealed that only the interaction between ear training and temperament system was significant (F (1,80) =3.64, p<.001). Accordingly, while ET group participants rated the Huzzam makam as more vital in ET stimuli, the OT group participants rated the OT stimuli as more vital. Considering the development of vitality means without its levels and direction over time, it is possible to say that the vitality experience was influenced and was congruent with the temperament system employed in the ear training courses. The post-hoc test for this significant interaction showed that the statistical significance originated from the vitality experience of the OT group in OT (OT: M=2.18SD= .20, ET: M=1.79 SD= .20; t (104) =1.93, p<.05). No other factors or interactions were significant (for the full table, see Appendix AQ).

Afterwards, I employed another model to understand the differences between countries. The model results revealed that the vitality experience of Huzzam makam differed in accordance with countries (F (1,52) =13.60, p<.001). Accordingly, as is the case with the pre-to-mid measurement period, the vitality means of the UK participants (M=2.08 SD= .11) in the Huzzam makam was higher than the TR participants (M=1.67 SD= .11) means. On the other hand, all other factors and interactions were non-significant (for the full table, see Appendix AR).

5.3.4.3 Unease

I tested how temperament-based ear training class participation could influence the unease means of UK participants in the Huzzam makam. Here, I entered time (pre-to-mid; mid-to-post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions but only for the mid-to-post rating period. I again excluded the timbre factor as it was non-significant in all models. As is the case with the previous second-order factors, in order to understand whether having a direct or indirect syntactic exposure might affect the uneasy experience, I separated and introduced the results as pre-to-mid and mid-to-post periods.

Figure 5.14 (A) shows the unease means of both ear training groups in the UK across three measurement points. According to the model results between pre-to-mid measurement, the interaction between ear training and temperament system (F (1,102) =23.30, *p*<.001) was statistically significant. Furthermore, the interaction between time, ear training course and temperament system (F (1,102) =4.91, *p*<.05) was also significant, indicating that the UK participants' unease means changed according to the temperament systems and participated ear training courses from pre-to-mid period. Accordingly, the ET stimuli means decreased in both groups. On the other hand, the means in OT stimuli remained stable in the UK-ET group but increased for the UK-OT ear training group. Further post-hoc analysis also revealed that this significance originated from the OT group's increased unease means in OT stimuli from pre (M=1.75 SD= .09) to mid (M=.2.27 SD=.05) measurement (*t* (102) =2.19, *p*<.05). This result could be interpreted as: without explicit syntactic exposure, temperament-based ear training might induce less unease (sadness and tension) experience in familiar temperament systems than unfamiliar temperament systems. On the other hand, all other factors and interactions were non-significant (for the full table, see Appendix AS).

Subsequently, I tested the unease means of TR participants from pre to mid measurement in Huzzam makam. Figure 5.14 (B) shows that although OT group's unease means decreased in both temperament systems, the decrease in the TR-ET group was remarkably higher specifically for the ET stimuli. The linear model results also confirmed this general decrease by a significance in time factor (F (1,121) =3.84, *p*<.05; pre: M=.1.55 SD= .08, mid: M=1.38 SD= .08). On the other hand, this decrease was not a function of temperament systems or ear training courses (for the full table, see Appendix AT).

I then built another model for understanding the differences between countries. Accordingly, results showed that the unease means in the Huzzam makam was differed in accordance with the country (F (1,53) =12, *p*<.001). Based on the results, the Turkish participants (M=.1.44 SD= .06) experienced the Huzzam makam as inducing less unease (sadness and tension) than the UK participants (M=.1.87 SD= .08) when listening to the Huzzam makam. The analysis did not reveal any significant effect of temperament systems or the interaction of temperament systems and ear training courses (for the full table, see Appendix AU).

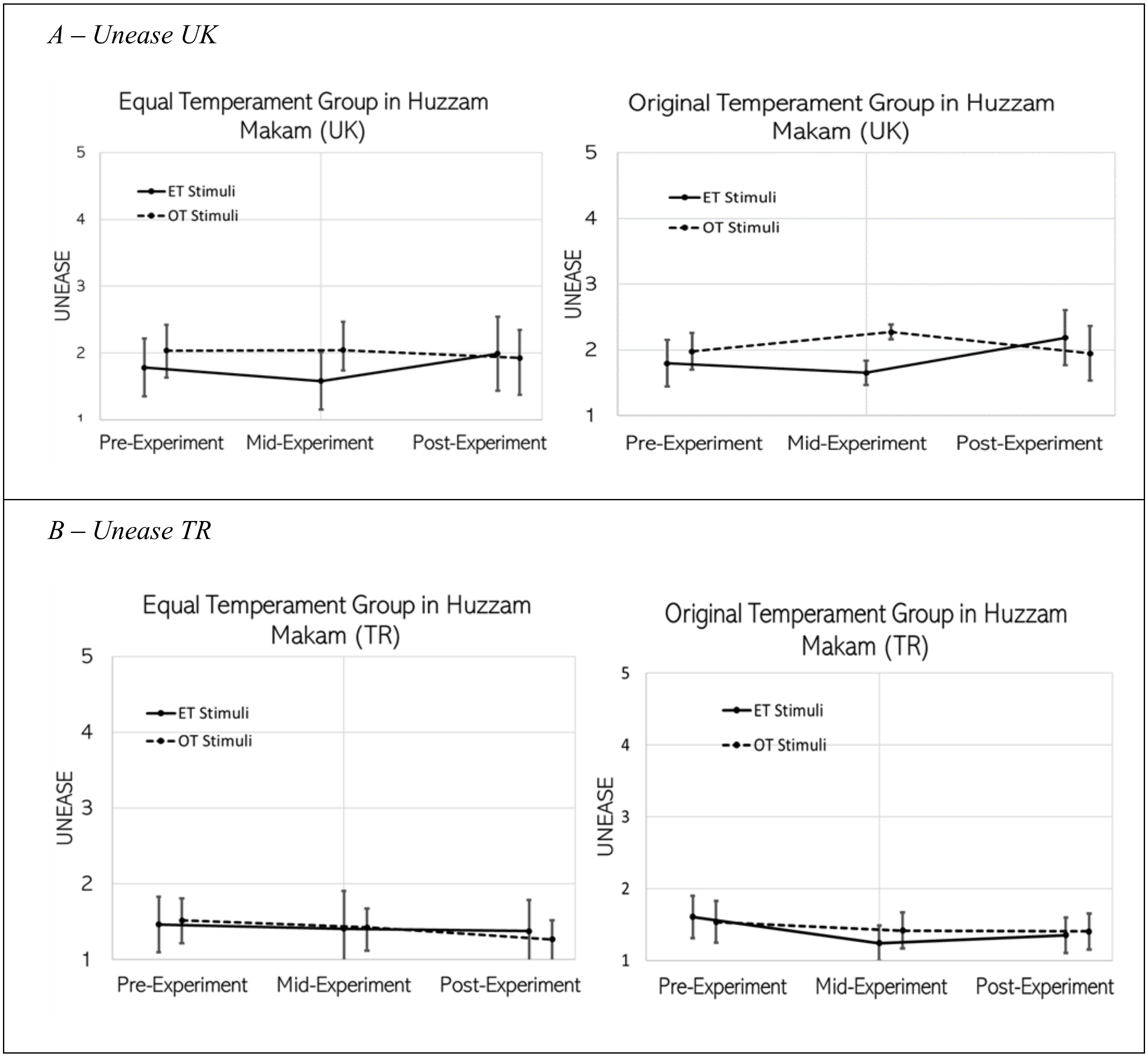


Figure 5.14. Error-bar graph of fixed effects estimated for unease GEMS factor for Huzzam makam in both countries separated by time (pre vs mid vs post-experiment), ear training type and stimulus temperament system with 95% CI.

I then employed another model for the unease means to see whether having direct syntactic exposure to the Huzzam makam could influence their unease means. Here, I again entered time (pre, mid, post), ear training course (OT, ET), temperament systems (ET, OT) and instrumentation (oud, piano, kanun) into the model with all possible interactions but only for the mid-to-post rating period.

Despite the first period of ear training classes indicating a less unease (sadness and tension) experience in ET stimuli for both ear training groups, this situation changed after having direct syntactic exposure to the Huzzam makam. The mid-to-post measurement part of figure 5.14 (A) shows that, while the UK-ET group's unease means in ET stimuli increased, OT stimuli means decreased. On the other hand, OT group's unease means in OT stimuli decreased but increased in ET stimuli between mid-to-post measurement. Even though overall F-test results did not show a statistical significance for time, ear training and temperament system interaction, I ran a post-hoc test using the Sidak method since I observed a possible difference in the UK-OT and ET group means. According to the post-hoc results, the increased unease means of ET stimuli in UK-OT group was statistically significant (mid measurement: M= 1.79, SD=.21, post measurement: M=2.19, SD=.21; t (102) =2.22, $p<.05$) which can be interpreted as a possible temperament-based ear training effect (for the full table, see Appendix AV).

Subsequently, I employed another model for the unease means of TR participants in Huzzam makam between mid to post measurement. Figure 5.14 (B) shows that while the ET group's unease means decreased in both temperament systems, the unease means of OT group in OT stimuli decreased but increased in ET stimuli. However, the analysis did not reveal any significant effect of temperament systems or the interaction of temperament systems and ear training courses (for the full table, see Appendix AW).

I then employed another model to understand the differences between countries. According to the model results, the uneasy experience of the Huzzam makam was different in accordance with the country (F (1,53) =12, $p<.001$). Based on this result, Turkish participants (M=.1.36 SD= .06) experienced less unease when listening to the Huzzam makam (sadness and tension) than the UK participants did (M=.1.97 SD= .10). On the other hand, all other factors and interactions were non-significant (for the full table, see Appendix AX).

5.3.4.4 Summary of the Effect of Ear Training on Emotional Experience of Huzzam from Pre to Mid Measurement

To understand literal temperament system effects and due to employing a ‘from easy to difficult’ teaching method, the Huzzam makam’s syntax features were introduced to participants in the last two weeks. Here, I aimed to understand if temperament systems are a parent system of any syntactic construction and if it can be learned by repeated exposure; despite not having exposure to the Huzzam makam’s syntax structures in the first half of the exposure phase, participants’ emotional experience should have been congruent with the employed temperament system in the ear training courses. In this way, I would have had a chance to test whether these emotional responses were either a schematic or a veridical memory outcome in case of congruency effect.

The analysis of sublimity means in the Huzzam makam showed that the UK-OT group’s sublimity means increased in accordance with the employed temperament system from pre to mid measurement (indicated by a statistically significant interaction between time, ear training and temperament system). In contrast, although there were various changes in means of TR ear training groups, these differences were not influenced by temperament systems. The further country-wise analysis showed that the UK participants experienced more sublimity than the TR participants did in the Huzzam makam. No other main factors or interactions were significant in sublimity second-order score analysis.

The vitality analysis of the UK participants revealed that the UK-OT group’s vitality means increased from pre to mid measurement (indicated by a statistically significant interaction between time and ear training); however, this increase was not a function of the taken temperament system. On the other hand, the TR-OT group’s vitality experience was influenced by the taken temperament system from pre to mid experiment (indicated by a statistically significant time, ear training and temperament system interaction). The analyses in order to understand country-wise differences revealed that the UK participants experienced the Huzzam makam as more vital than the TR participants did.

The analyses in order to understand the uneasy experience of the UK participants showed that although the unease means in ET stimuli decreased in both UK ear training groups (ET, OT), the OT group's unease means in OT stimuli increased and this increase was statistically significant. On the other hand, the analysis of TR participants revealed that both ear training groups' unease means decreased in both temperament system stimuli. The analysis in order to understand the country-wise differences showed that TR participants experienced less unease (sadness and tension) when listening to the Huzzam makam than the UK participants did.

5.3.4.5 The Effect of Ear Training on Emotional Experience of Huzzam makam from Mid to Post Measurement

In order to understand whether the observed experience of the Huzzam makam might change and differ by having a direct syntax exposure to the Huzzam makam, I analysed the GEMS-25 second-order means of Huzzam makam from mid to post measurement period.

The analysis of sublimity means in the UK revealed that although the observed congruency effect in the OT group's OT stimuli continued in this period (indicated by a statistically significant interaction between ear training and temperament system), the same congruency effect was not observed in the UK-ET group. On the contrary, TR participants' sublimity experience in the Huzzam makam was not influenced by temperament systems from mid to post experiment. Further analysis to understand country-wise differences revealed that the Huzzam makam was experienced as more sublime by the UK participants than the TR participants. Also, results showed that this experience was common in both temperament stimuli types (indicated by a statistically significant interaction between country and temperament system).

The analyses to understand the vitality experience of the UK participants in Huzzam makam revealed that even though the vitality means of Huzzam makam increased after having direct exposure to the Huzzam makam syntax (indicated by a statistically significant time main factor), this increase was not a function of employed temperament systems in ear training courses. On the other hand, TR participants' congruent vitality experience in the Huzzam makam resumed between the mid to post measurement period indicated by a statistically significant interaction between ear training and temperament system. Further analyses in order to understand country-wise differences showed that the Huzzam makam was experienced as more vital by the UK participants when compared to the TR participants.

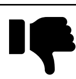
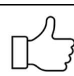
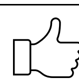
The analyses of uneasy experience in the UK revealed that even though the unease means of the UK-ET group in ET stimuli increased in contrast to the observed congruency between the pre- to mid-measurement period, the UK-OT group's experience was congruent with the employed temperament system in the ear training course. On the contrary, the uneasy experience of TR participants in the Huzzam makam was not influenced by any experimental conditions. Further analysis to understand country-wise differences revealed that TR participants continued to experience less unease in Huzzam makam compared to the UK participants.

5.4 The Summarised Findings of Experiment 1 and 2

Overall, Experiment 2 aimed to understand the role and effect of temperament systems on emotion induction and verbal identification performance of taught makams. In terms of experimental conditions, Experiment 2 is differentiated from Experiment 1 by its duration, containing makams and including an additional cross-cultural comparison between TR and the UK participants. Table 5.2 illustrates the assumptions and findings of Experiment 1 and Experiment 2. The thumbs-up figure represents an assumption that was confirmed, and a thumbs-down represents an assumption that was not confirmed. In addition to that, the last column gives brief information about important findings in related assumptions.

Table 5.2

The Summary of the Findings in Experiment 1 and 2

Assumptions Based on Statistical Learning in Music and Musical Expectation	Experiment 1	Experiment 2	Did assumptions differ between countries?	Finding Highlights
Familiar and unfamiliar temperament systems induced different emotion intensities.				A familiar temperament system (ET) induced more vitality than an unfamiliar temperament system (OT). Different makams induced different emotions, and the intensity of induced emotions differed in terms of temperament systems. These experiences also differed according to country.
The verbal identification performance is congruent between the type of course and type of stimulus temperament system				Temperament systems did not influence the verbal identification performance of Hicaz, Huzzam and Karcigar makams.
After attending ear training courses, participants' GEMS second-order means were congruent between the type of course and type of stimulus temperament system.		 		Vitality and unease means were congruent between the type of course and type of temperament system but was not constant across all groups, makams and temperament systems. These means varied in accordance with country, ear training group and whether they had direct syntax exposure.

5.5 Discussion

This experiment's primary purpose was to extend and retest the previous study's findings (Experiment 1) on the role of temperament systems on emotion induction and verbal identification performance of Turkish makams. Furthermore, this study also aimed to understand whether this experience differs cross-culturally. The result demonstrated that different makams induced different emotions, and as in Experiment 1, the intensity of these emotional qualities changed according to the presented temperament system (RQ1). The verbal identification performance of the Huzzam and Karcigar makams increased after ear training classes; however, these increases did not depend on the temperament system employed in the training or listening experiment at both countries (RQ2). In addition to that, the verbal identification performance did not differ by countries (RQ3). Being exposed to the Karcigar and Huzzam makams during the ear training did increase the experience of sublimity, but this increase did not depend on the temperament system employed in the ear training courses. Furthermore, exposure to these two makams decreased the experience of uneasiness according to the employed temperament system in the temperament-based ear training course (RQ4). These experiences differed according to the ear training group, countries, and whether they had direct or indirect syntactical exposure to the taught makams (RQ5).

The first research question of the experiment was about the emotional experience of the participants listening to the Turkish makams in two different temperament systems pre-experiment. In contrast with Experiment 1's pre-experiment results, per country results suggested that there was no visible effect as a result of the temperament on the emotional experience of the presented makams. As was the case in Experiment 1, I predicted that the unfamiliar temperament system would lead to different emotional responses due to violations of expectations.

There could be several reasons to explain the differences in emotion induction between Experiment 1 and Experiment 2. The initial rationale could be the music, listener, and the situational context – all of which are crucial factors while experiencing music (Jorgensen, 1988). The first causal explanation might be the individual differences such as age, personality, engagement in music and musical training (Abel & Chung, 1996). For instance, Castro and Lima (2014) reported that advancing age was associated with selective decrements in recognition of sadness and fear. Furthermore, they reported that years of music training were also associated with enhanced recognition accuracy while experiencing emotions in listening to music. In Experiment 2, the musical training and age means were lower than in Experiment 1. So a possible explanation could be that these individual differences might have caused this disparity between Experiment 1 and Experiment 2.

The second causal explanation would be the musical surface differences between makams in Experiment 1 and Experiment 2. Although sharing some common musical features (i.e., the Hicaz tetrachord), the makams used in Experiment 2 were completely different from the makams that were used in Experiment 1. Therefore, it is also plausible to conclude that syntactical differences might have caused these differences which point to a potential relation between the syntactic construct and the temperament system used while listening to music.

An alternative causal interpretation for the observed differences would be the test power. To understand whether it was the cause, I merged the GEMS second-order means of two countries in order to analyse with a larger sample. Accordingly, as was the case with Experiment 1, all participants experienced the familiar temperament system (ET) as more vital than the unfamiliar temperament system (OT). Thus, one might conclude that familiar temperament systems induce more vitality than unfamiliar temperaments while listening to Turkish makam music.

Another point of interest was whether temperament-based ear training could influence the participants' verbal identification performance. As in Experiment 1, although participants' verbal identification performance in the Karcigar and Huzzam makams increased, this increase did not depend on either temperament or ear training courses. A number of studies suggest that pitch and pitch structures (i.e., motif, phrase or a melody) are mostly connected to semantic memory and its subcategories such as categories and schemas (Snyder, 2000). Moreover, the formation of these subcategories is shaped by the cultural features of individuals (Demorest et al., 2016) and repeated exposure (Huron, 2006; Snyder, 2000). Although other music structures such as tonality (Lynch, Eilers, Oller, Urbano, & Wilson, 1991) and rhythm (Schellenberg & Trehub, 1999) are believed to be culturally biased and dependent on that culture's repeated exposure, the results from Experiment 1 and 2 suggest that neither familiar temperament system nor the exposure of participants to temperament-based ear training classes have an effect on participants' verbal identification performance.

On the other hand, from a mere exposure effect perspective (Zajonc, 1968), I predicted that due to having a passive exposure to culture-specific aspects, TR participants might exhibit a higher identification performance on presented makams. Here, I assumed that even though TR participants did not have domain-specific knowledge about Turkish makam music, they may have been subject to a mere exposure effect due to their engagement in society and culture. However, the comparative analysis among countries revealed that the verbal identification performance did not differ according to country, which could suggest that passive exposure to culture was not effective in verbal identification performance.

In this study, the verbal identification task can also be described as a conceptual categorisation task. Snyder (2000) states that verbal identification of a musical subset is also a consequence of the conceptual categorisation ability of long-term and semantic memory. Furthermore, he adds that these categorisation abilities are also established with an individual's memory performance and own values, so they are strictly idiosyncratic (Snyder, 2000). One possible conclusion could therefore be that the verbal identification task in these experiments might also be dependent on individual performance success.

Finally, I investigated whether temperament-based ear training classes lead to any change in the emotional experience of listening to two makams and whether the observed emotion inductions were congruent with the temperament system employed in the ear training courses. In contrast with the findings from Experiment 1, results suggested that over a four-week-long ear training period, emotional experiences significantly differed in second-order factors in terms of intensities and directions. According to these data, we can infer that extending exposure time in a temperament-based ear training setting would influence the emotional experience when listening to the presented makams. On the subject of whether emotion inductions were congruent with employed temperament systems in ear training courses, in contrast with Experiment 1, the current study found that temperament-based ear training influenced the means of sublimity and uneasiness second-order factors by the employed temperament systems and this interacted with countries. In the first measurement period (pre to mid), TR participants and the merged model showed that participants rated ET stimuli in the Karcigar makam as more sublime than its OT version. Moreover, in the second measurement period (mid to post) overall, the UK participants rated the ET version of Karcigar makam as more sublime than its OT version. In broad terms, the sublimity second-order factor can be defined as a combination of aesthetic emotions such as wonder, transcendence and tenderness (Trost, Ethofer, Zentner & Vuilleumier, 2011), which also could be qualified as semantic constructions (Shimamura & Shimamura, 2012). The sublimity experience in familiar temperament system (ET) is in line with the suggestions by Sluckin, Hargreaves and Colman (1983) and findings by Madison and Schiölde (2017), who reported that familiarity and repeated listening increases the aesthetic judgment and likeability of listening to music pieces.

Furthermore, the results can also be explained by Juslin's (2013a) *Aesthetic Judgment* conceptualisation. According to him, specific input ways (perceptual, cognitive and emotion) define and form aesthetic criteria that combine with individual and social context and result in either liking or disliking an aesthetic emotion if it exceeds the aesthetic threshold. Among these ways, cognitive input represents schematic and socially determined memory representation in aesthetic judgment, which stores domain-specific knowledge about music (Juslin, 2019). Therefore, these possible memory representations could have induced more sublimity while listening to familiar temperament systems. On the other hand, Cupchik and László (1992) pointed out that aesthetic judgment criteria might depend on expertise, such as having a musical education, and therefore expert listeners might have a more cognitive reception than naïve listeners. Thus, given the educational profile of the participants, potential cognitive reception might lead to the conclusion that on sublimity experience, without considering any emotional quality and direction between measurement points, the intensity of emotion induction of the Karcigar makam was influenced by familiarity and the cognitive reception of schematic knowledge of familiar temperament.

Repeated exposure to music could form a powerful exogenous means of memory modulation (Krumhansl, 1997). In support of this assumption, the unease experienced by the UK participants (sadness and tension) in the familiar version (ET) of the Karcigar makam was either on the same or a lesser level than the unfamiliar version (OT) in pre-experiment. Following that, the UK-OT group's unease means changed in accordance with the employed temperament system in the ear training. According to the results, while initially the familiar temperament (ET) version of Karcigar makam induced less unease (sadness and tension) and the unfamiliar temperament system (OT) induced more unease, after having a temperament-based ear training course, the unease experienced during the Karcigar makam in the OT system (congruent) decreased but increased for the ET version (incongruent). Furthermore, this congruency effect in unease means resumed in the subsequent measurement period. The observed congruency effect in the OT system could be attributed to the structural mere exposure theory.

In contrast to the classic mere exposure effect, the structural mere exposure effect is based on an underlying rule system for stimulus generation and is characterised by the tendency to prefer new stimuli that conform to the rule system, independent of surface structure (Reber, 1993; Zizak & Reber, 2004). In line with this suggestion, one might conclude that as a result of repeated exposure to the OT system, the UK-OT group experienced the Karcigar makam in OT system as inducing less unease (sadness and tension) than the familiar ET temperament system.

On the other hand, though the model results of the Huzzam makam indicated a statistically significant interaction between time, ear training and temperament systems, in the first period, the change of experience was only in rating direction which appeared as a decrease in ET stimuli. Moreover, although the means between the mid to post measurement period showed a visually observable effect of the employed temperament system in the OT group, this was not statistically significant.

The decrease in the unease second-order factor between pre to mid might be explained by Berlyne's (1970) conceptualisation of the familiarity effect. According to Berlyne (1971), if a stimulus was previously encountered, and if you expose it more than once, it is preferable to the unfamiliar one. Thus, one might conclude that for lack of syntactic exposure, familiar temperament systems induce less sadness and tension emotions (unease) when compared to unfamiliar temperament systems. Also, Berlyne's (1971) approach might explain the emotion induction differences between these two makams. On the other hand, one can also easily speculate that the effect of temperament systems might be imperatively tied to the syntactic structures such as a scale or a tetrachord. As described before (see section 3.4.3), the Huzzam makam was the most unfamiliar makam among taught makams. It is therefore also plausible to conclude that the unfamiliarity level might influence the mental reception of pitch representations and thus influence emotion induction while listening to music.

The unease experienced by the Turkish participants during the Karcigar makam was not influenced by the temperament system main factor across all measurement periods. Moreover, this trend was also observed in the Huzzam makam apart from for mid to post means. In this period, the time factor was statistically significant, and this might also be interpreted as a result of a repeated exposure (Halpern & Müllensiefen, 2008; Mungan et al., 2019; Peretz, Gaudreau, Bonnel, 1998). Increased exposure to temperament-based ear training courses in this study also corroborates the earlier findings by Wong and Margulis (2008), who investigated the effect of repeated exposure using an ecologically valid orchestral piece that was unfamiliar to all participants. According to captured trends through repeated exposure, they found that repeated exposures can reshape the time course of an affective engagement, particularly a decline in experience of tension (Wong & Margulis, 2008). These results provide further support for the hypothesis that repeated exposure may cause a decline in affective engagement (unease) experience over time, bearing in mind the possibility for potential passive exposure to the makam music structures.

Across all measurement points, the rating intensities per second factors differed in accordance with country. As such, the means of the UK participants were significantly higher on sublimity and vitality second-order factors than the TR participants. This result may be due to the fact that the call for participation in ear training classes clearly stated that the courses were going to be on Turkish makam music and its theoretical features. Therefore, in addition to increasing the UK participants' curiosity, the call for participation might have also contributed to the "otherness" and "exoticism" perception (Huron, 2006), which could result in more attentive and absorbed participation. Another significant result from Experiment 2 is the unease experienced by the Turkish participants. Indeed, the mean of the TR participants across all makams was significantly lower than that of the UK participants in all measurement periods. These differences can be explained in part by the proposals of mere exposure effect (Zajonc, 1968). According to Zajonc (1968), simple and neutral exposure to novel stimuli increases liking of that stimuli, and this increase in liking is much stronger at a subliminal level than at a supraliminal level. In order to understand the link between exposure and liking in music, Szpunar, Schellenberg and Pilner (2004) investigated whether the likeability of given orchestral pieces could differ according to incidental and focused listening conditions. Similar to the observed experience of uneasiness by the TR participants, the listeners who heard the same stimuli incidentally (i.e., in the background) experienced a monotonical increase of liking as a function of exposure, even though they had no explicit memory.

Moreover, Monahan, Murphy and Zajonc (2000) argued that these repeated subliminal exposures could also enhance the affective responses of the stimuli in positive ways. When the subcomponents of the unease second-order factor (sadness and tension) are considered as negative affective dimensions, the TR participants' experience of less unease might be evaluated as a consequence of the mere exposure effect in music. One could therefore hypothesise that passive exposure influences the extent of uneasy emotions experienced while listening to Turkish makam music.

It is also encouraging to evaluate these results by Clarke's (2005) conceptualisation on ecological learning in music. According to his concept, passive exposure is a profoundly active organism itself, but without any external human agency's direct guidance and by encountering an eco-cultural sounding environment, listeners build an internal representation of musical components (p.39). However, this process does not mean that listeners permanently have these representations. In fact, external agencies shape these interactions with sounds and modify them by the perceivers' own goals (Clarke, 2005). Thus, even though they did not have a conscious or auditorial knowledge of the presented makams, TR participants might have experienced less unease due to the surrounding eco-musical environment.

5.5.1 Conclusions

This experiment suggests that temperament systems play a significant role in the emotional experience of those listening to Turkish makam music, and this experience differs according to the received ear training course and cultural background. Also, the results of this investigation show that the temperament system's impact on emotion induction might be a consequence of familiarity through repeated exposure via training. However, the results also suggest that this emotional experience might be related to the syntactic structure of makam, and this might also influence the experiences made from temperament systems. Therefore, the generalisability of these results is subject to certain limitations. On the other hand, temperament systems do not play a role in participants' verbal identification performance in the Karcigar and Huzzam makams.

6. Experiment 3

6.1 Aims

The previously conducted two experiments' results indicate the existence of veridical expectations. Since the role of temperament systems in schematic expectations and its relationship with familiarity is still not defined clearly, in Experiment 3, I aimed to understand the role of the temperament system on schematic expectations via 'goodness-of-fit' ratings (GOF). In order to gain GOF ratings, I used a modified version of the probe tone method (Krumhansl & Kessler, 1982). The probe tone method is a context/key-related method that aims to understand intra-key hierarchies within a scale. Although the first usage of the method was mainly based on a major scale and single pitch probing within a major scale (Krumhansl & Kessler, 1982), subsequently many usages of the probe tone method were based on modified versions such as probing other scales (Krumhansl & Kessler, 1982) and different musical temperaments (Castellano et al., 1984; Krumhansl et al., 2000). Here, the listener first listens either to a single tone or a melody based on selected temperament systems and subsequently the listener listens to a probe tone, and the listener's task is to rate it as a completion of the scale or melodic context (1 = "very bad" to 7 = "very good"). In this experiment, listeners were asked to rate the 'goodness-of-fit' of a probe tone to a preceding unfamiliar Turkish makam musical motif. The motifs were extracted from selected Turkish makam songs, and the probe pitches were presented in either a pitch that belongs to the unfamiliar Turkish makam music temperament system (OT, pitches unequally divided into 24 intervals) or a pitch that belongs to the familiar Western equal temperament system (ET, pitches equally divided into 12 intervals). The main prediction was that if an absolute pitch position within an octave takes place in the mental representation of pitch because of statistical learning in music (Huron, 2006), then a pitch that belongs to OT (unfamiliar) will violate the expectation of the participant and hence will cause relatively lower GOF ratings when compared to ET (familiar) pitch. Furthermore, I wanted to see whether the 'goodness-of-fit' ratings of participants could change after taking a temperament-based four-week-long ear training class in the Huzzam makam as a result of temperament-based ear training.

6.2 Methods

6.2.1 Participants

Thirty-one participants from TR (mean age = 22.46, SD = 3.40, 24 females, formal music education mean = 12.61 years, SD = 3.56) who were formally educated only in the Western 12 Equal Temperament system participated in this experiment. All participants declared that they were unfamiliar with Turkish makam music.

6.2.2 Ear Training Content

Experiment 3 was conducted in Turkey and all participants attended the ear training courses in Experiment 2. The ear training course aimed to expose participants to the selected makams through temperament-based ear training courses. Here, participants attended temperament-based ear training courses only in the Huzzam makam. Participants received one hour of ear training per week for two weeks. The ear training concept included the theoretical and auditory features of the Huzzam makam. For more ear training details, please see Section 3.4.1.

6.2.3 Musical Stimuli

All melodic contexts were created from the Hicaz, Huzzam and Saba makams which were different from the Western 12 ET system's common scales. As mentioned before (see Section 3.4.3), the main criterion of selection was the intensity of unfamiliar pitch positions within a makam scale. Accordingly, while the Hicaz makam consists of the fewest unfamiliar pitch positions, the Segah makam consists of the highest amount of unfamiliar pitch positions. The Huzzam makam was selected as the makam taught in the ear training courses. In terms of familiarity, the Huzzam makam falls into the middle of the highest and lowest amounts of unfamiliar pitch position scale. In order to create probe excerpts, a musical phrase from makam songs was extracted. Following that I divided these phrases into three meaningful musical motifs. All probe positions were played after a musical motif to preserve the thematic identity of the selected phrase and presented only in piano timbre. To obtain the ET version of the created excerpts, I adapted all motifs according to the nearest pitch principle (see Section 3.4.2).

The probe tone studies mostly focus on intra-key hierarchies. However, the main aim of this experiment was to explore the exact effect of a given pitch and the interval that was inherently composed. In order to select which probe pitches will be presented, I analysed previous probe tone studies. In Krumhansl and Kessler's (1982) seminal tonal hierarchy study, the minor second (100 cents distance from *f0*) and the major sixth (900 cents distance from *f0*) had the lowest tonal consonance values. As consonance perception might cause a higher GOF rating tendency, I assumed that gathering the rating data through lower consonance valued intervals might help understand the exact role of pitch position in the listener's mental pitch representation. Hence, I restricted our probe pitches to those from the minor second (the corresponding *Bakiyye* that has 90.2 cents distance from *f0* in Turkish Makam Music Theory) and major sixth (a corresponding interval that has 905.84 cents distance from *f0* in Turkish Makam Music Theory) intervals. Since Turkish makam music theory does not have a categorisation of larger interval categories like in Western music theory, I am going to use Pythagorean major sixth (27/16 ratio) name for the interval that is composed of OT pitch. Inherently, the probe technique could also induce the categoric interval knowledge of listeners. As it is difficult to distinguish whether the GOF ratings are based on absolute pitch position or the mental representation of categoric interval knowledge, and also to increase the readability of the presented results, I am going to refer to temperament system differences with interval names throughout this section.

Every makam phrase consisted of two *minor second* or *Bakiyye* and one *major sixth* or *Pythagorean major sixth* (PM6) intervals. The placement of these intervals per makam phrase was different. For instance, the Hicaz makam's motif probes followed an order as m2/bakiyye-m2/bakiyye-M6-PM6. Moreover, in order to prevent any rhythmic confusion, all selected makam pieces were either in familiar *Quadruple* or *Duple* meters. For more details about presented makam phrases and probe positions, please see Figure 6.1 and Appendix AY

a) Huzzam Makam

ET OT

b) Hicaz Makam

ET OT

c) Segah Makam

ET OT

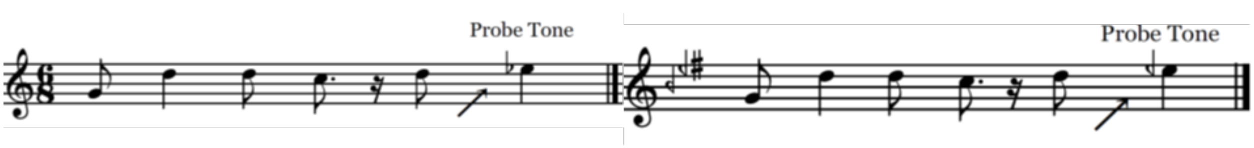


Figure 6.1 The preceding motifs and probes of selected makams in ET and OT

a) Huzzam b) Hicaz c) Segah

Note: Arrows refer to played probe tones after motifs

6.2.4 Procedure

A pre-training experiment was conducted in a listening laboratory and embedded into an online questionnaire. The experiment's online questionnaire comprised of two sections that took approximately 20-35 minutes to complete (depending on the participants' rating speed). In the first section, the participants were asked to fill in certain sociodemographic questions and were informed about the experiment's flow. At the end of this section, the participants were required to test the volume and playback capacity of the provided earphone. In the second section, participants listened to and rated two versions (OT, ET) of three different probes per makam, totalling 18 probes in random order. Every probe was presented on a new page with a brief instruction about the purpose of the 'goodness-of-fit' rating. The probes were rated through a seven-point scale which ranged from strongly does not fit to strongly fits. Screenshots from the online questionnaire can be found in Appendix BD.

For the experimental procedure, please see section 3.4.5.

6.3 Experiment 3 Results

6.3.1 Effect of Temperament System in Pre-Experiment

I employed Hierarchical Linear models for predicting the ratings in pre-experiment to assess whether 'goodness-of-fit' ratings differ according to presented temperament systems (using the mixed procedure in SPSS). As fixed effects, I entered the probe (ET, OT) temperament system and makam type (Hicaz, Huzzam, Segah) as main factors and interactions of these main factors. Visual inspections did not reveal any deviations from normality and reported predictors of best fit obtained by backwards-model approach (West et al., 2006). Here, I first employed a full-factorial model and started to reduce fixed-effect terms from the highest interaction terms to the main factors respectively. All estimations were based on restricted maximum likelihood with compound symmetry heterogeneous covariance structure (which produced the best AIC fit indices).

Figure 6.2 presents the mean fit of all probe tone ratings in the pre-training experiment separated by the probe's makam type and temperament system. According to hierarchical linear model, the temperament system main factor ($F(1, 206) = 4.09$, $p<.05$) significantly influenced the 'goodness-of-fit' ratings. Contrasts revealed that ET probes (M= 5.48, SD=.16) were rated higher than OT probes (M= 5.08, SD=.16). The makam type main factor was also statistically significant (F (2,135) =3.38, *p*<.05). Accordingly, the participants' fit ratings in the Huzzam makam (M= 5.48, SD=.16) were higher than the Hicaz and Segah makams (M= 4.93, SD=.19). Furthermore, there was also a statistically significant interaction effect between temperament system of probe and makam type (F (2,143) =3.69, *p*<.05), indicating that the fit ratings of temperament systems differed in accordance with the makams. To break down these interactions, I employed a post-hoc test using Sidak corrections. The post-hoc analysis revealed that in general the ET version of probes (M= 5.45, SD=.24) in Hicaz makam was rated as a better fit than its OT version (M= 4.41, SD=.27), and this difference was statistically significant (*t* (300) =2.96, *p*<.001).

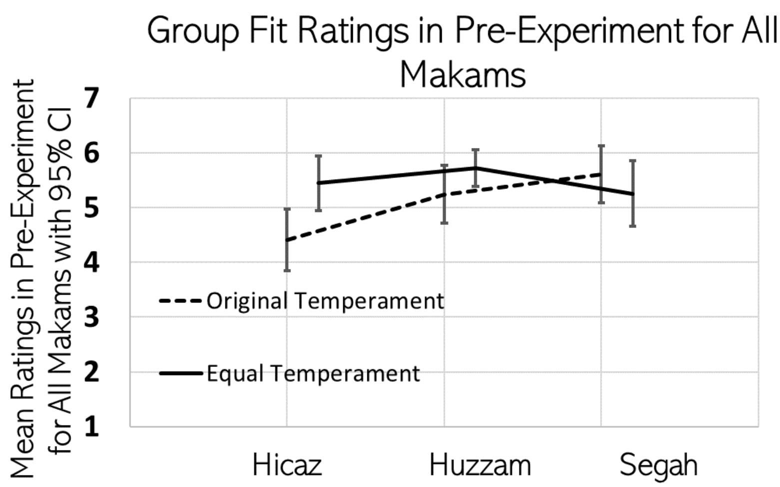


Figure 6.2. Mean of 'goodness-of-fit' ratings in pre-experiment separated by stimulus temperament system and makam type without probe positions with 95% CI.

6.3.2 The 'goodness-of-fit' Ratings of Motifs/Intervals

Subsequently, I employed Hierarchical Linear models per motifs to see whether the probe's ratings of temperament system might differ according to composed intervals (m2/Bakiyye-M6/Pythagorean M6). Here, I entered the probe temperament system (OT, ET), makam type (Hicaz, Huzzam, Segah) and probe intervals as fixed effects with all possible interactions. Probe intervals consisted of two m2 (bakiyye) and M6 (PM6) per makam phrase (see Section

6.2.3). All estimations were based on the *compound symmetry* covariance structure which produced the best-fit indices.

Figure 6.3a presents the mean of the ‘goodness-of-fit’ ratings in the pre-training experiment separated by temperament system of probe and intervals in Hicaz Makam. According to our model, the probe interval factor was statistically significant (F (2,45) =20.02, p<.001), indicating that the ratings differed in accordance with composed intervals. In line with this result, the M6-PM6 interval in the Hicaz makam (M= 3.01.45, SD=.29) was rated lower when compared to the other two intervals (m2 interval: M= 5.09.45, SD=.29; m2 interval: M= 5.59, SD=.29). Furthermore, the interaction between the temperament system of probe and probe interval factors (F (2,52) =3.44, p<.05) was also statistically significant, indicating that the temperament system of probe ratings differed in accordance with composed intervals. Further post-hoc results revealed that the first m2 (ET) interval (M= 5.64, SD=.35) in the Hicaz makam was rated significantly higher than its bakiyye (OT) (M= 4.55, SD=.35) version (t (96) =2.66, p<.001).

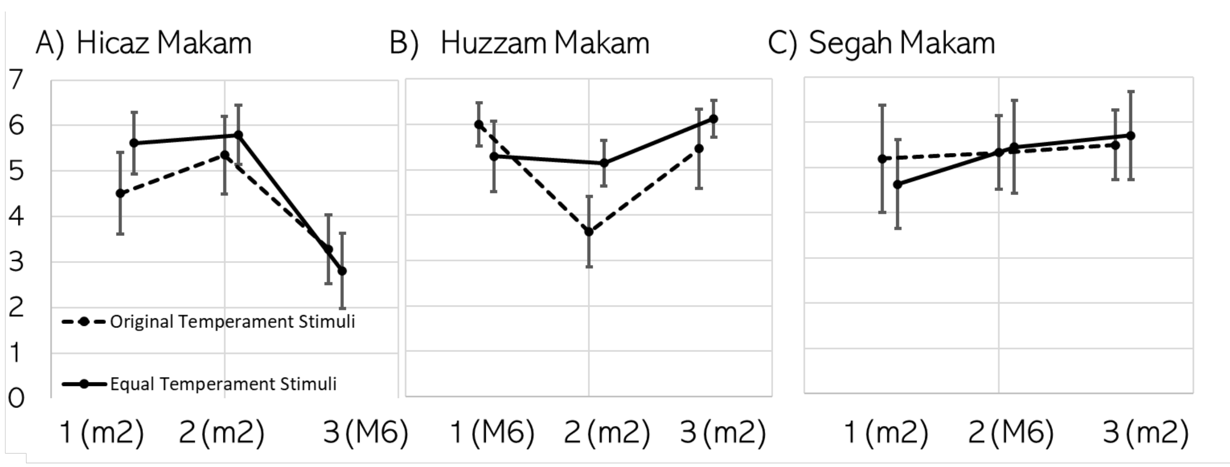


Figure 6.3. Error-bar graphs of fixed effects estimated for ‘goodness-of-fit’ ratings separated by probe intervals and the probe’s temperament system with 95%CI. a) Hicaz makam b) Huzzam Makam c) Segah Makam

Subsequently, I employed another model for the Huzzam makam, and figure 6.3b presents the mean of the ‘goodness-of-fit’ ratings in the Huzzam makam separated by temperament system of the probe and probe intervals. According to our linear model, the temperament system of probe (F (1,81) =6.05, p<.01) and probe interval (F (2,64) =9.62, p<.001) main factors were significant, indicating that the ratings differed in accordance with composed intervals and the temperament version of these intervals. Based on these results, overall, the ET version (M= 5.09.45, SD=.20) of the presented intervals was rated higher than the OT intervals (M= 4.95, SD=.20). Based on the significant main effect of the probe interval factor, the 'goodness-of-fit' ratings of the second m2 interval (M= 4.44, SD=.23) was rated lower than the other two intervals (M6-PM6 interval: M= 5.63, SD=.23; m2-bakiyye interval: M= 5.76, SD=.23). Even though overall F-test results did not show a statistically significant interaction between temperament system and intervals, I employed a post-hoc test using the Sidak method as I observed a possible difference between the temperament system of probes. According to the results, the ET version of the second m2 (M= 5.06, SD=.25) was rated higher than its OT (Bakiyye) version (M= 3.82, SD=.25). This difference was also statistically significant (t (96) =2.66, p<.001), indicating that the ET version of m2 was found by participants to be a better fit.

Afterwards, I applied the same statistical procedure for the "'goodness-of-fit'" ratings in the Segah makam. According to the model, neither the temperament system of probe nor the interactions of temperament systems were significant.

6.3.3 Effect of Ear Training on 'Goodness-of-fit' Ratings of Huzzam Makam

In order to understand whether ear training leads to any change in probe ratings and if either is influenced by the temperament systems employed in ear training courses, I employed Hierarchical Linear models per interval that were presented in the Huzzam makam context. As the Huzzam makam was the content of the course and the only potential hypothesis of change is for the Huzzam makam, I excluded other makams from the models. Here, fit ratings of intervals in the Huzzam makam were the outcome variable, and time (pre, post), temperament system of the probe (ET, OT) and ear training course (OT, ET) were the main factors with all interactions. Predictors of the best model were obtained using the backwards-model approach and all estimations were based on *compound symmetry heterogeneous* covariance structure, which produced the best AIC fit indices.

Figure 6.4 (A) presents the 'goodness-of-fit' ratings of M6/Buyuk Mucennep intervals in the

Huzzam context. According to the model results, only the temperament system of the probe main factor was statistically significant ($F(1,64)=6.71$, $p<.01$), indicating that the 'goodness-of-fit' ratings of participants differed in accordance with the temperament system of the probe. Based on this result, the 'goodness-of-fit' ratings of M6 in ET (M= 5.96, SD=.23) were higher than the OT version (M= 5.20, SD=.23). No other main factors or interactions of main factors were significant (for the full table, see Appendix AZ).

I subsequently employed another linear model for 'goodness-of-fit' ratings in the m2/Bakiyye interval. Figure 6.4 (B) shows that the OT probe's fit ratings (bakiyye) decreased from pre to post experiment in both ear training groups. On the other hand, while the ratings of m2 interval in the ET system remained stable in the ET ear training group, the OT group ratings in ET system (m2) increased from pre to post experiment. The overall F-test results revealed that the temperament system of probe ($F(1,62)=39.84$, $p<.001$) and time ($F(1,62)=4.22$, $p<.05$) main factors were statistically significant. Contrasts revealed that, in general, participants' 'goodness-of-fit' ratings decreased from pre (M= 4.43, SD=.24) to post (M= 3.83, SD=.19) experiment. Based on the significant F-test result in the temperament system factor, the ET probe (M= 5.24, SD=.24) was rated as a better fit to the preceding motif than its OT probe version (M= 3.08, SD=.24), indicating that despite having temperament-based ear training, in general, the ET version of the m2 interval was found to be a better fit than its OT version.

Besides, the interaction between time and temperament system of the probe ($F(1,62)=8.05$, $p<.001$) was statistically significant, indicating that the fit ratings of the presented probes changed over time. In order to understand the differences, a post-hoc test using Sidak correction was employed. The results revealed that overall the 'goodness-of-fit' ratings in OT interval decreased from pre (M= 3.85, SD=.28) to post (M= 2.27, SD=.28) experiment and this difference was statistically significant ($t(62)=-3.25$, $p<.001$). On the other hand, there was no significant interaction between the probe and ear training system, meaning that participants' ratings were not influenced by the temperament system employed in the ear training courses (for the full table, see Appendix BA).

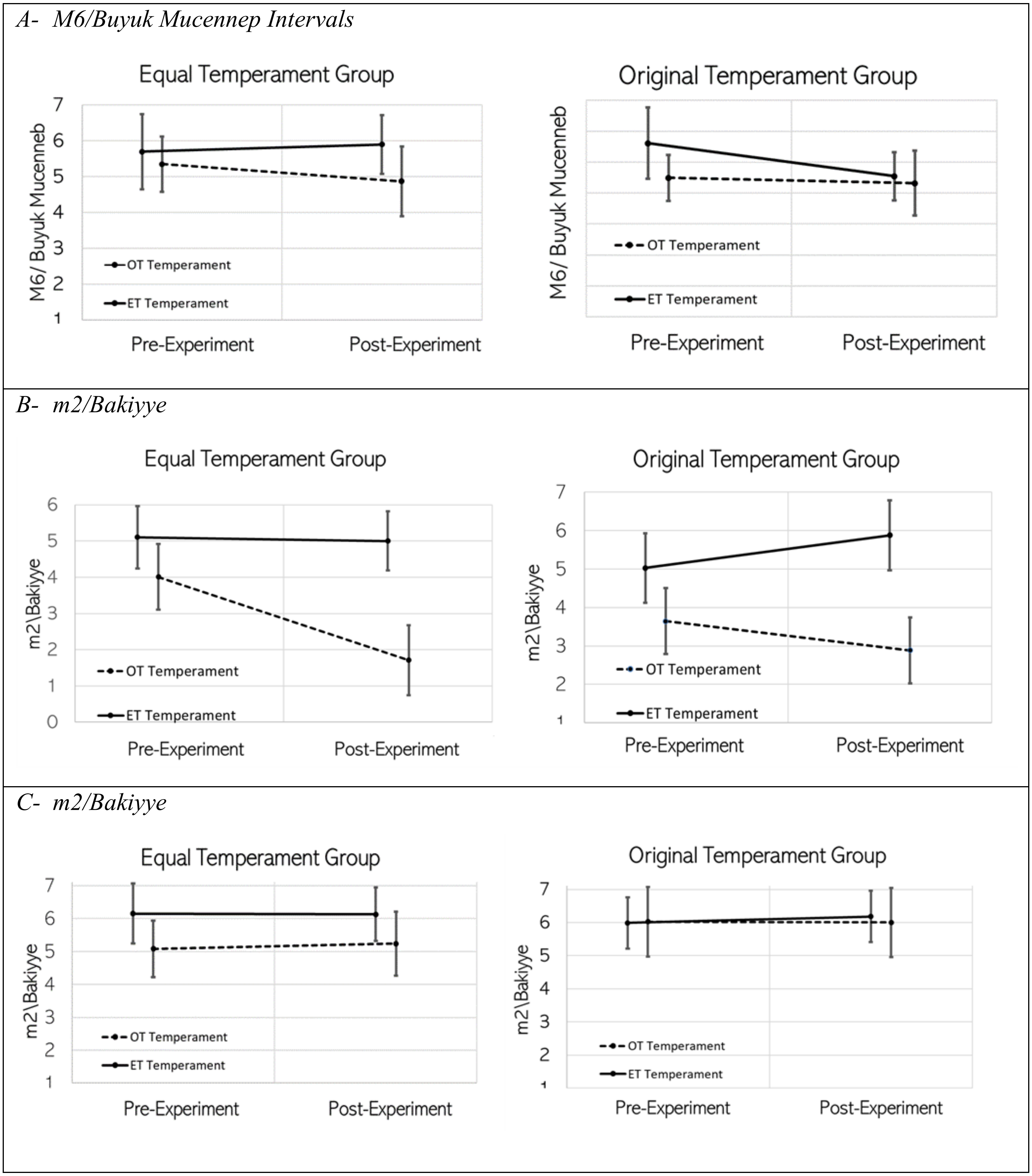


Figure 6.4. 'Goodness-of-fit' ratings of intervals in Huzzam makam separated by time (pre vs post experiment, ear training course type, and temperament system of the probe with 95% CI a) M6/Buyuk Mucennep b) m2/Bakiyye c) m2/Bakiyye.

Figure 6.4 (C) shows the fit ratings of the second m2/bakiyye intervals within the Huzzam context. According to the model results, neither the main factors nor their interactions were significant (for the full table, see Appendix BB).

6.4 Discussion

The primary purpose of this experiment was to understand the role of temperament systems on schematic memory by presenting a pitch position either with OT pitch (unfamiliar) or with an ET pitch (familiar) by probe technique (Krumhansl & Kessler, 1982). The manipulated differences between probe tones were 5.84 cents (in proportion to Western categoric M6 interval) and 9.8 cents (in proportion to Western categoric m2 interval). In the first step, at baseline, as a consequence of general exposure, I expected higher ratings in familiar temperament system (ET) pitches than unfamiliar temperament system (OT) pitches regardless of makam context and motifs. The model results per makam (without motif analyses) pre-experiment demonstrated that only the Hicaz makam was rated higher in the familiar temperament system. Although there was a visually observable higher fit rating in the familiar temperament system (ET) version of the Huzzam makam, this was not statistically significant. On the other hand, the 'goodness-of-fit' ratings for the Segah makam were not influenced by temperament systems. The 'goodness-of-fit' rating analyses per motifs showed that only familiar m2 (ET) intervals in Hicaz and Huzzam makam contexts were rated as higher fit than its unfamiliar version (OT) by participants. In the second step, because of temperament-based ear training courses, I also expected higher 'goodness-of-fit' ratings according to the temperament system employed in ear training courses. The results suggested that being exposed to a temperament-based ear training class did not change the 'goodness-of-fit' ratings according to the employed temperament system in ear training courses.

Although previous studies (Curtis & Bharucha, 2009; Castellano, Bharucha, & Krumhansl, 1984; Krumhansl et al., 2000; Morrison, Demorest, & Stambaugh, 2008b; Perl- man & Krumhansl, 1996) suggest a perceptual advantage of the culture-statistical regularities of pitch-related structures in music, in our experiment this tendency was observed only in the Hicaz makam and only in the m2 interval in Hicaz and Huzzam makam contexts in pre-experiment. The effect of tonal context might explain the factor that has caused this partial experience.

Huron (2006) indicates that musical knowledge interacts with individual and music structural differences in many ways. Even though a note-to-note definition would be difficult for a causal explanation due to the multidimensional aspect of the pitch, some studies also reported that different music-structural components in familiar contexts might influence the experience of temperament systems. Graves and Oxenham (2017) compared four different tonal contexts in their study to understand how a context could affect the recognition of a pitch position. Their result suggested that Western-influenced participants performed more precisely within a major scale when compared with other contexts. Although it did not share the same structure music theoretically, the Hicaz makam was the closest makam that shared certain structural overlaps (Narmour, 1990) with Western music. Furthermore, when we look more closely at the components of the Hicaz makam, it shares a Rast pentachord that is similar to the first tetrachord of a major scale. Thus, a related explanation could be that these participants benefited from this hypothetically familiar structure that caused a much stronger temperament experience in Hicaz makam.

Regarding interval relations, studies mostly examined interval preferences and magnitude with or without a well-known musical context with either sine or complex tones by using the 12-tone equal temperament system. The results of these studies suggested that octaves and other typically used intervals can be performed between 10 to 40 cents deviation (Moran & Pratt. 1926; Terhardt, 1969). Rakowski (1990) tested the intervals of ET via a set of experiments. He tested all possible intervals with or without musical context in his study, letting participants adjust preferred intervals or selecting them via systematically created intervals. Results suggested that small intervals are remembered much better than other interval categories and tuned better than larger intervals in a free tuning task. The same behavioural tendency was also observed in the categorical interval identification task. Consistent with these findings, the motif analysis showed that the ET version of m2 intervals in Hicaz and Huzzam makam contexts was rated as a better fit by participants, indicating a possible temperament system accommodation in schematic memory. However, although the statistical analysis did not reveal a statistically significant interaction for other m2 intervals in both contexts, the participants rated the ET version of m2 intervals distinguishably higher than its OT version. Also, in line with Rakowski's (1990) reported results, in the Hicaz and Segah makams, the larger intervals were rated similarly. In general, therefore, it seems that the temperament system experience might be much stronger in smaller intervals and might be dependent on other components of familiar music.

I also wanted to find out whether temperament-based ear training could influence the 'goodness-of-fit' ratings of participants. I predicted that if temperament systems are encoded as a result of statistical learning, then the participants' ratings would change after participating in a temperament-based ear training class. Here, I also expected a quick and robust learning increase for the employed temperament system since the findings of previous studies suggested superior statistical learning in participants with more music training for auditory materials (Vasuki, Sharma, Demuth, & Arciuli, 2016; Paraskevopoulos, Kuchenbuch, Herholz, & Pantev, 2012). In contrast with previous studies, it was found that although the exposure phase was notably longer, exposure via temperament-based ear training courses did not change the participants' 'goodness-of-fit' ratings. This outcome is contrary to that of Loui, Wessel, & Kam (2010) and Leung and Dean's (2018) studies, who reported robust learning for a new temperament system and its cognitive generalisation. This rather contradictory result may be due to melodic materials. For instance, in Loui, Wessel and Kam's (2010) study, they extracted all melodies from a 3:5:7 harmonic chord ratio, which serves a similar role as a major chord ratio (4:5:6). Furthermore, they created a cadence-wise chord progression approach, which is very common in Western music. On the other hand,, in this experiment, the selected excerpts were entirely dissimilar in terms of syntax constructions. For instance, the Huzzam makam's dominant factor was the third degree of the scale. Therefore, this rather contradictory result may be due to unfamiliarity levels with presented melodic materials. On the other hand, it is worth bearing in mind that there may be confounding variables that may interfere.

The most important finding from the post-ear training period was the rating tendency of participants for their familiar temperament system, which was revealed as either a constant and increased rating trend (except for OT group in M6 interval) or a decrease in unfamiliar ratings. According to these data, we can infer that temperament systems might be encoded in schematic expectations as a consequence of statistical learning in music.

6.4.1 Conclusion

This experiment aimed to understand whether temperament systems are encoded in schematic memory by a probe technique using subsets of unfamiliar Turkish makam music via dissonant intervals (m2/M6). Although the current experiment's findings are not generalisable to all included musical materials, this experiment has shown that temperament systems are a music-structural component that might take place in schematic expectations. On the other hand, temperament-based ear training courses did not influence the 'goodness-of-fit' ratings of participants. Moreover, the findings also suggest that the consolidation of temperament systems in memory and mental representation might also be confounded by other musical structures familiar to listeners, such as the first tetrachord of the major scale.

7. General Discussions and Conclusions

The next section will first provide a summary of findings and subsequently the main discussions of the thesis.

7.1 Main Findings

This thesis's main aim was to understand and reveal the effect of temperament systems on music-induced emotions and verbal identification performance in Turkish makam music. Experiment 1 investigated the proposed method and the emotional experience of UK participants on selected Turkish makam music. Despite employing the same method with Experiment 1, Experiment 2 differed due to including different makams, length of ear training course, sample size, and adding Turkish participants as an additional experimental factor. Experiment 3 investigated temperament systems' effect in schematic memory via the ratings of 'goodness-of-fit' and tested whether this could change after receiving temperament-based ear training courses and whether these ratings were congruent with the employed temperament systems in ear training courses.

To conceptualize whether temperament systems influence the music-induced emotions and verbal identification performance, we grounded our hypothesis on the statistical learning theory in music (Huron, 2006), which conceptualises that emotions in music are a stepwise product of statistical learning, memory and musical expectations. Here, participants received structured information about makams which is contrary to the traditional approach of statistical learning studies. However, it is also important to bear in mind that participants did not get any information about temperament systems that were used in the ear training classes. In this way, I preserved the unconscious learning nature of temperament systems. Accordingly, I predicted that if temperament systems affect musically induced emotions, familiar and unfamiliar temperament systems will arouse different emotional experiences in the same makam excerpts. For this reason, I adapted and presented Turkish makam music excerpts in OT (24 UE Interval, unfamiliar) and ET (12 ET Interval, familiar) systems. In addition to formally and culturally unfamiliar participants (UK participants), I recruited Turkish participants who may have been passively exposed to the makam music but formally educated under ET system. Therefore, in addition to understanding the effect of the surrounding eco-sonic environment on music emotional experience and verbal identification performance, I also aimed to gain an accurate understanding of statistical learning in music, which claims that the familiarity of a musical structure plays a significant role in music emotional experience (Huron, 2006).

In both Experiment 1 and Experiment 2, the results indicated that the intensity of emotional factors differed according to presented temperament systems. Likewise, in both experiments, familiar temperament systems induced more vitality than unfamiliar temperament systems. Even though the GEMS second-order factors did not show any significant difference after ear training exposure in Experiment 1, in Experiment 2, unease means decreased in accordance with the employed temperament system as a possible result of the extended ear training period. However, this congruency effect was not observed in all ear training courses and makams, and differed according to countries. Also, the sublimity means of participants increased after ear training courses, but this increase was not influenced by the employed temperament system in the ear training course. On the other hand, although vitality means showed differences across measurement points, these differences were non-significant. Furthermore, the emotional experiences of GEMS second-order factors also differed according to ear training and countries. In all measurement points, while the UK participants experienced more vitality and sublimity than Turkish participants, Turkish participants experienced less uneasy emotions (sadness and tension) than UK participants.

Another aim of the thesis was to understand the effect of temperament systems on verbal identification performance in Turkish makam music. Accordingly, identification performance results showed that even though the verbal identification performance increased, this increase was not a function of temperament systems or ear training courses. In two experiments of this study, the verbal identification performance of selected makams in both countries depended on the time factor, which might be evaluated as a potential consequence of repeated exposure in music. On the other hand, the verbal identification performance of makams did not differ according to the country or ear training group.

Experiment 3 set out with the aim of assessing the accommodation of temperament systems on schematic expectations through 'goodness-of-fit' ratings. For this purpose, I used a modified version of the probe technique (Krumhansl & Kessler, 1982) by manipulating the pitch positions either with OT pitches (unfamiliar) or with ET pitches (familiar). Another aim of

Experiment 3 was to test whether obtained 'goodness-of- fit' ratings might change after having temperament-based ear training courses. The fit rating analyses per motif in te pre-experiment showed that the familiar ET (m2) intervals in Hicaz and Huzzam makam contexts were rated higher than unfamiliar version (OT) of intervals. However, this tendency was not observed with the Segah makam and larger (M6-PM6) intervals in all makam contexts. Even though m2 results indicate that temperament systems are a structural component of music that might be acquired by culture-statistical regularities in music, it could be argued that the familiar congruent results were due to other familiar musical structures. In the second step, as a result of temperament-based ear training classes, I expected higher 'goodness-of-fit' ratings, those that are congruent with the temperament system employed in ear training courses. The results suggested that being exposed to temperament-based ear training classes did not change the 'goodness-of-fit' ratings by the employed temperament system in ear training courses.

7.2 Discussions

To the best of my knowledge, the study presented here is the first experiment series to investigate the effect of temperament systems on emotion induction and verbal identification performance in Turkish makam music, therefore all findings are exploratory and interpretative in nature. The following sections will discuss the main findings as subsections.

7.2.1 The Effect of Temperament Systems on Long-Term Memory

Along with other dimensions, long-term memory is a crucial factor in forming musical expectancy. Although many studies specifically focused on temperament systems (Loui et al., 2010; Leung & Dean, 2018) even when otherwise defined, the role of temperament systems on schematic expectation has not yet been a specific subject of research. On the other hand, as a complementary detail but not an actual example, some of the interval studies (Rakowski, 1990) suggested that listeners can remember smaller intervals much better than larger intervals. Results from pre-experiment also suggested a similar finding with this result. Participants rated the m2 interval in ET as a significantly better fit in Hicaz and Huzzam makam contexts. However, it is also important to note that this finding was not observed with the Segah makam, which was also the most unfamiliar makam among those presented makams. Therefore, these findings cannot be true to all makams. If we consider the familiarity degrees of the Hicaz and Huzzam makam as more familiar than the Segah makam, it is plausible to interpret this finding as a potential effect of minimum familiarity. Thus, besides the conclusion that the smaller intervals (and therefore the absolute positions of the constituents of the smaller m2 interval) are better represented in schematic memory, the minimum familiarity perception could also play a role in schematic expectation of temperament systems. Furthermore, this observation also supports the suggestion made by many cross-cultural studies, which is that when listening to music from a foreign music system, perceived stability or the 'goodness-of-fit' of pitches depends on how they would be judged if the context were their familiar musical system (e.g., Castellano et al., 1984; Krumhansl et al., 2000; Morrison, Demorest, & Stambaugh, 2008b; Perlman & Krumhansl, 1996).

Many studies also suggest that listeners can learn unfamiliar music pieces (Saffran, Johnson, Aslin, & Newport, 1999) both implicitly and explicitly. In both cases, the results indicate that listeners can acquire the governing musical regularities they were exposed to during short-term exposure (Jonaitis & Saffran, 2009; Rohrmeier, Rebuschat, & Cross, 2011). However, this robust learning effect might also depend on the complexity of the musical grammar (Rohrmeier & Cross, 2009) and the exposure phase's length (Jonaitis & Saffran, 2009). After having an ear training class, participants' 'goodness-of-fit' ratings were incongruent with the temperament system employed in ear training classes. Furthermore, in both ear training classes, participants rated the familiar temperament system (ET) intervals similar to pre-experiment or relatively higher in familiar temperament system intervals. Given the unfamiliarity degrees of Turkish makam music examples, a possible explanation might be the complexity of the stimuli.

Nevertheless, it is believed that long-term memory formation is based on the detection of statistical regularities in the environment (Reber, 1997). According to Reber, stimuli are abstracted over time by being exposed to stimuli variants. Reber terms this as '*the abstractive view of knowledge acquisition'*. Based on this view, McAdams (1989) suggests that organisational systems like tonality and meter fall into abstract knowledge structures because they embody a system of relations that apply across many exemplars. For McAdams, this type of musical knowledge serves as a foundation to establish the relative stability or salience relations among the values in a given dimension, which might cause more concrete explicit learning. Therefore, it is plausible to say that, given the hierarchical position of temperament systems and their relationship to pitch subsystems, learning might not take place in the absence of familiar musical structures.

7.2.2 The Effect of Temperament System on Emotion Induction

For the temperament role on emotion induction, the following conclusions can be drawn from the two experiments presented in this thesis:

The elicitation of emotion by music is a process depending on multiple interacting factors. Among these factors, pitch is one of the most ambiguous musical features which plays an important role in emotion induction (Gabrielsson & Lindström, 2010). Considering that pitch is a fundamental component of a sound and, therefore, music, few studies have investigated pitch and the role of pitch components on emotion induction when compared to other music structures. Furthermore, reported studies showed that there are also contradictory findings to generalise on the pitch effect on emotion induction. For instance, while some studies suggested that high pitches are often associated with positive adjectives (Coutinho & Cangelosi, 2009; Eitan & Timmers, 2010), some studies associated high pitch with negative emotions such as fear and anger (Ilie & Thompson, 2006). Also, some studies reported that age and musical expertise might influence the emotional experience of music. In their study, Castro and Lima (2014) reported that people of older ages might experience a decrement in sad emotions, and music expertise might enhance the happiness experience. The pre-training period in both studies showed significant differences in the emotion induction of various makams and their temperament versions. It is important to bear in mind the temperament system effect was not observed on every presented makam. A possible explanation could be that the temperament system experience might depend on the musical syntax presented in the experiments. Furthermore, this experience might also be a consequence of listener features such as individual musical schemas, which might also interact with music structural features in a unique way (Huron, 2006). Since answering these questions is almost impossible, one might conclude that, besides potential structural components that cause induction, there might also have been some subjective differences that influenced the emotional experience of temperament systems while listening to the presented makams.

Previous studies showed that positive responses to music increase if a listener's familiarity with musical structures is confirmed when listening to a musical piece (Hunter & Schellenberg, 2011; Schellenberg, Peretz & Vielillard, 2008). In the pretraining period of two different experiments, participants experienced more vitality in the ET of Nihavend and Hicaz makams. The Nihavend makam is comparable to the minor scale. Even though the minor scale is often associated with sadness, this familiarity might have induced more vitality in ET compared to unfamiliar temperaments because of confirmation of expectation, which also supports the previously mentioned idea that the temperament experience could be more visible if combined with familiar syntaxes. On the other hand, even though Hicaz makam has similarities to the Mixolydian mode with a flattened second degree and Hungarian minor (also known as Bartok minor), the Hicaz makam has relatively more unfamiliar syntax when compared with Nihavend makam. In addition to those potential familiarity probabilities while experiencing the Hicaz makam, this makam's structural components might have also caused vitality experience. Accordingly, the Hicaz makam consists of a Rast pentachord which is comparable to the first tetrachord of a major heptatonic scale. Many studies reported that major scales are associated with happiness and modes are often associated with valence changes (Husain, Thompson, & Schellenberg, 2002). It is therefore likely that such connections exist between temperament and familiar syntax structures, and that participants might have therefore experienced more vitality in Hicaz makam when in a familiar temperament system.

Huron (2006) claimed that the origin of the confirmation of expectations and hence emotion arousal are most likely through the mechanism of statistical learning (Vapnik, 1968). According to him, this schematic but yet replaceable knowledge is gained by sustained exposure to commonplace musical patterns. In Western music, the theory has been studied with many aspects. For instance, Pearce and Wiggins (2005) provided a statistical model that accounted for 80% of the variance in the patterns of expectancy regularities found in the music itself. Furthermore, more ecological and hermeneutic approaches such as Narmour's (1990) implication-realisation and Meyer's (1956) propositions also confirmed that cultural music features and musically notated structures are learned and, as a consequence, form expectations.

Although the above-mentioned studies represent general observations about statistical learning, and therefore expectations, in music, this study's primary aim was to understand whether the absolute position of a pitch in an octave continuum has an effect on emotional induction. Therefore, pitch-related expectations were of particular interest in this study. According to Huron (2006), pitch and pitch structures such as intervals are learned through exposure. As a result, the auditory system is exposed to the surrounding sound environment and it creates its own (unconscious) representation of pitch. Subsequently, via listening activities and musical training, this perceptual experience becomes a conscious experience. In brief, he argued that a mental representation of a pitch or another pitch structure success is determined mostlyby the structure of the stimuli encountered by the auditory system. Although the auditory system encounters different representations, the listener still prefers a representation that conforms to its mental coding. In line with this theoretical framework, the participants in my experiments experienced more vitality in a familiar temperament system if it was matched with a familiar syntax. It could therefore be said that a listener can also develop expectations for an absolute pitch position in an octave exposition that influences emotional qualities that depend on confirmation or violation of those expectations.

7.2.2.1 The Effect of Ear Training on Emotion Induction

Another important aim of this thesis was to understand whether the temperament system has an effect on emotion induction. This was investigated through simulating a statistical learning environment via temperament-based ear training classes. In Experiment 1, ear training courses did not change the participants' vitality experience in both groups. As in the pretraining period, participants rated the ET version of Hicaz makam as more vital than OT stimuli. Also, the participants' unease means significantly decreased as a potential result of mere exposure. However, this did not depend on either the temperament system or ear training factors. In Experiment 2, some findings indicated that emotion induction in Turkish makam music is influenced by the temperament system that the participant was exposed to through ear training classes as a function of extended exposure times. Accordingly, the experience of uneasy emotions (sadness and tension) provoked by Karcigar makam and Huzzam makam decreased over time, in accordance with the temperament system employed in ear training groups. The observed congruency between type of ear training course and type of stimuli temperament is in line with suggestions of "structural mere exposure" which argues that after exposure to a new rule system, the organism tends to prefer new stimuli that conform to that rule system, independent of surface structure (Reber, 1993). Thus, the results from Experiment 2 regarding the unease second-order factor also complement the pre-experiment results, which underscore the temperament system as a statistically learned element in music and hence on emotion induction in music as a possible result of extended exposure times. On the other hand, although there were statistically significant findings in other second-order factors (sublimity, vitality), these were not a function of the temperament system variable. The question of why it was not consistent across presented excerpts and induced emotions is not easy to answer. It seems that as Gabrielsson and Lindström (2010) suggested, the relative contribution of every single musical factor cannot be determined conclusively because of intercorrelations between factors.

Altogether, it is plausible to conclude that while in the first experiment the participants' decreased experience of uneasiness was a consequence of mere exposure (Zajonc, 1968), in Experiment 2 the response of uneasiness was a result of "*structural exposure"* (Zizak & Reber, 2004) and therefore the result of a statistically learned element. This outcome is contrary to that of Parncutt and Hair (2018), who suggested that integer ratios (otherwise known as temperament systems) are fundamentally incorrect and that neither the listener nor the performer switches between two ratios of one interval. Therefore, the findings in this thesis might be the first step to understanding the effect of temperament systems on cognitive and emotional functions during music listening.

Music listening often gives rise to various sorts of associations, some of which may involve emotional meaning (Pike, 1972). Hence, it is possible to evaluate unease ratings through veridical expectations, too. Even though participants were not aware of having "temperament-based" ear training (they were only aware of makams), they might have also developed veridical expectations due to listening to the same stimuli throughout the experiments as a consequence of episodic memory. Moreover, they might have also developed an associative coding (Juslin, 2019) by learning makam names.

To conclude, for Huron's hypothetical mental representation of pitch, temperament systems could be included considering the Experiment 1 and 2 results, suggesting that temperament systems or a pitch position in an octave continuum are effective in the induction of musical emotions.

Figure 7.1 illustrates a modified version of Huron's hypothetical mental representation of pitch. Accordingly, the listener needs to unconsciously retain a cumulative distribution of all the pitches that originated from the temperament system by cultural exposure. The cultural exposure is relatively unconscious and takes its source from the culture's and family's musical surrounding environment. Subsequently, the listener starts to retain interval relations and then starts to retain higher structures which consist of more than two pitches. Following this, the whole process turns into an auditory perceptual learning process in a conscious way (Goldstone, 1998) to retain a more concrete representation of pitch elements. In doing so, the listener gains a more elaborate outlook and conscious sensitivity about instructed pitch structures. Then the confirmation or violation of these structures might potentially result in an emotional reaction (Egermann et al., 2013; Huron, 2006).

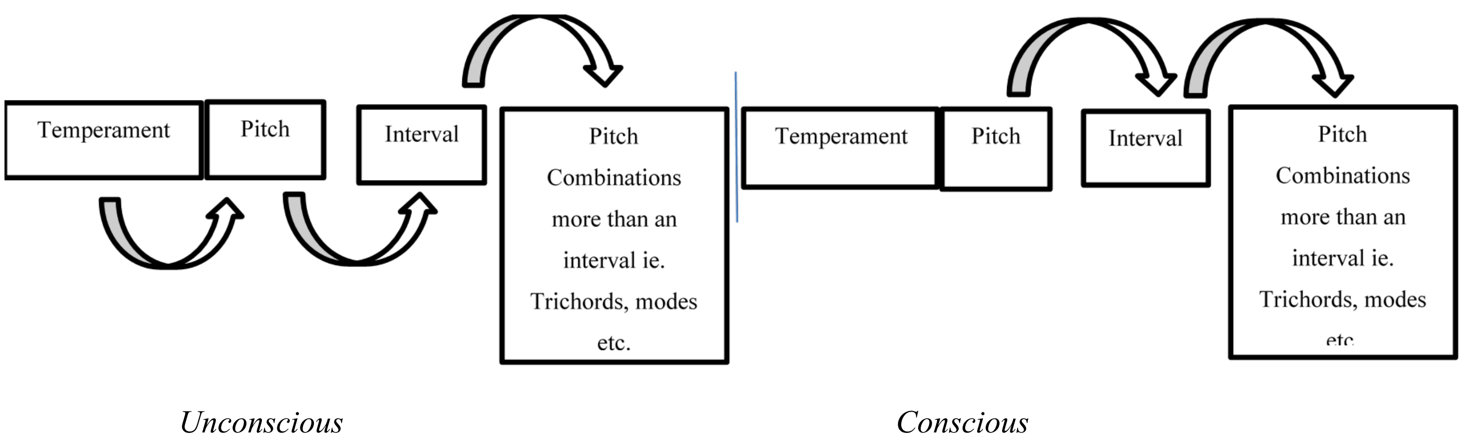


Figure 7.1. A modified illustration of hypothetical mental pitch representation that affects the emotion induction process during music listening.

7.2.2.2 Cross-Cultural Differences in Musically Induced Emotions in Turkish Makam Music

In Experiment 2, the influence of potential passive exposure to the Turkish makam music on emotion induction was also investigated. The GEMS second-order means in Experiment 2 indicated that, throughout measurement points, Turkish participants experienced significantly less uneasy emotions (sadness and tension) in all the makam excerpts they listened to. The results regarding unease means suggest that although TR participants did not have an explicit and formal experience of Turkish makam music, they still experienced fewer uneasy emotions (sadness and tension) when compared with UK participants. This indicates that passive cultural exposure to the makam syntaxes might also be effective in the emotional experience of music.

The experience of uneasiness in the TR participants could also be evaluated under the mere exposure effect. Bornstein's (1989) and Berlyne's (1970) theories (the *two-factor* model and *perceptual fluency/attributional* model), those based on mere exposure effect (Zajonc, 1968), posit that listeners may enjoy previously encountered stimuli even if the perceiver cannot explicitly remember or understand the stimulus. However, in both theories, continuous passive or active exposure to a similar stimulus could also result in disliking. In many instances though, investigations in music (Schellenberg et al. 2008; Szpunar et al. 2004) showed that listeners both remember and like musical stimuli despite various exposures. Given the continuous lower levels of uneasiness experienced by TR participants, one could conclude that although the listener was explicitly aware of receiving Turkish makam music, they still resume to experience more positive emotions while listening familiar music.

On the other hand, UK participants experienced more sublimity and vitality in general than the TR participants. It seems plausible to evaluate this experience as a function of the participant's personality and perception of exoticism for unfamiliar music. Matthews, Deary and Whiteman (1998) state that the personality dimension of being open to experiences might increase the aesthetic sensitivity, which could be characterised as sublime emotions. Moreover, the potential effect of perceiving music as exotic on emotion experience (Huron, 2006) might also have increased the UK participants' vitality and sublimity experience. From this perspective, the results of this thesis add significant knowledge to the emotional perspective of in-culture and out-culture participants' music induction experience while studying cross-cultural experiments.

7.2.3 The Effect of Temperament Systems on Verbal Identification Performance

Another main goal of the current study was to determine the effect of the temperament systems on the participants' verbal identification performance of makams. From the statistical learning and expectation perspective, I predicted that participants would outperform in their familiar temperament system if statistical learning shapes learning and memory processes. Although verbal identification rates of taught makams increased in both experiments, this increase was not a function of the temperament system or ear training courses.

In music memory studies, the theoretical approaches found that recognising and remembering a melody is based on abstract features (i.e., pitch) or surface features (i.e., timbre) (Halpern & Mullensiefen, 2008; Trainor, Wu & Tsang, 2004). Even though contextual cues have been the focus of extensive investigations in memory research, the question of which element of contextual cues are effective and how it provides relevant information is still not well defined or understood (Bower, 1981; Humphreys, 1978). Moreover, whether this kind of information originates from semantic or episodic memory is still not well understood (Mandler, 1979). The findings of verbal identification performance in this thesis suggest that no link may exist between temperament systems and verbal identification performance in Hicaz, Karcigar and Huzzam makams, and the verbal identification performance in music seems to depend more on temporal pitch relations (syntax) and constructions that help to recognise and recall the musical structure (Krumhansl, 2000; Schellenberg & Stalinski, 2013; Snyder, 2000). These results also align with the theory of "fuzzy-trace", which argues that listener memory is based on general gist rather than a verbatim memory (Brainerd & Reyna, 2002; Schellenberg & Stalinski, 2013). Alternatively, from a statistical learning perspective, a possible explanation for these results may be failed expectations. According to Schank (1982), remembering is most likely to occur when our expectations fail and enhance learning performance. Therefore, the failed expectations could be another factor (if not the only one) causing the verbal identification increase. However, without defining the real reason behind this gradual learning outcome, one might also speculate that the strongest reason behind verbal identification increase could also be the ear training courses.

7.3 Limitations

Even though this study is the first to investigate the effect of temperament systems, results are limited to Turkish makam music, and further investigations need to be done on other temperament systems in order to have a more unified understanding of temperament systems on emotional and cognitive skills. Another limitation of the study might be length of the ear training courses and unfamiliar musical structure itself. Learning an unfamiliar makam structure might require prolongation of exposure phase. Perhaps that is why participants did not exhibit a rapid learning of unfamiliar temperament in Experiment 3. Therefore, with the prolongation of the exposure phase, a better understanding might be gained on the learning of the unfamiliar makam structures as well as unfamiliar temperament systems.

Another limitation is related to the method to understand the accommodation of temperament systems. The sensitivity of participants is measured via GEMS-25 scale and probe tone ratings in all experiments. At first glance, even though these ratings might seem sufficient in order to draw conclusions on the effect of temperament systems, explicit identification tasks such as "identification of deviant pitches" might give a more in-depth understanding of the effect of temperament systems.

7.4 Future Directions

As part of the data-gathering process, two different studies have also been planned. Firstly, I am planning to conduct a research based on the emotion induction qualities of selected makams in this thesis and evaluate these qualities through cross-cultural perspective. By reporting these qualities cross-culturally it might add knowledge and enhance current literature on universals in music debate.

The second research I am planning is to conduct this thesis approach on the relation between exposure and music expectation through music experts of two traditions (Turkish 24 UE vs. 12 TET). In this way, I plan to gain deeper knowledge about the mental representation of absolute pitch positions while listening to music.

Another important suggestion for future directions is about cross-cultural studies. With the growing interest, the focus moved to the cross-cultural and universals side in order to understand underlying mechanisms as a human species that is not only for a culture or a tradition. However, this situation also brings challenges itself. One should focus on not only the diversities while conducting cross-cultural research but also observe and bring together these very diverse differences on a shared basis. Therefore, in addition to investigating a foreign kind of music by itself, there is also a focus on shared concepts such as temperament systems.

7.5 Outlook

Despite the remarkable advances and findings of pitch studies, the effect of pitch and pitch-related structures on emotion and verbal identification performance is still primitive and vague. The study presented here aimed to understand one of the pitch aspects: the effect of the temperament system. In Experiment 1 and 2, results suggested that the mental representation of temperament systems might also be influenced by syntactic construction. The nested relation between these two important factors brings the potential long-standing issue of having a clear picture of pitch components' effect on cognitive processes. Therefore, a greater focus on this relation could produce interesting findings that account more for temperament and its relations with sub-structures.

In addition, I was particularly interested in studying the effect of temperament systems on verbal identification performance. Theoretical investigations on how and which contextual cues are effective on recognition memory are crucial in this area of research. As the results highlighted, temperament systems did not influence the verbal identification performance of taught makams. Therefore, considering other components of music could also be the aim of further studies on music recognition memory and verbal identification of musical subsets.

Another significant contribution of this thesis is to investigate a particular musical system within its own reality by also comparing it with the 12 ET system. I believe studying different cultures' cognitive and emotional processes will overcome previously stated problems such as cultural diversity (Huron, 2008) and unipolarity of reported findings (Stevens, 2012) in the music psychology discipline. Even though some documentations of foreign kinds of music (from a Western perspective) have led to potential candidates for universals in music, which universals might be observable for all cultures still remains as a question (Huron, 2008). On the other hand, studying different cultures' psychological processes on its own terms with all aspects will kind help re-evaluation and comparison of previously reported findings in addition to having more concrete representation of other music cultures. Hence, I also suggest that future studies should consider cross-cultural studies within their own terms to have a more concrete understanding of investigated kinds of music.

To conclude, this thesis has examined the effect of temperament systems on emotion induction and verbal identification performance by grounding its perspective on statistical learning and exposure theories. This research project also has implications on other domains such as music education. With investigating the verbal identification performance, this thesis' data have provided important findings in order to understand conceptual categorisation processes behind musical structures. Therefore, this will also help music educators when planning their teaching approaches. Furthermore, the results provided by this thesis will also help to produce more comprehensive music technological tools that can be used by music researchers.

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APENDICES

Appendix A

Ear Training Course Aims and Attainment Targets

Aims

The curriculum for Turkish makam music in original temperament aims to ensure that all participants:

- Become **familiar** on the syntactical foundations of Turkish makam music.
- Can identify Karcigar Huzzam makams and dictate by using music language.
- Can identify and dictate unfamiliar 5/8, 7/8 and 9/8 rhythms.
- Can be able to vocalise related solmisation's in correct tune.
- Can understand the relations between tetrachords and pentachords.
- Can understand Karcigar and Huzzam makam's melodic behaviours and cadences.

Music is an interconnected and holistic subject in which participants need to be able to synchronise auditorily and visual representations of music together. The programme of study is organised into apparently distinct domains, but participants can have some difficulty due to seeking connections with their own taught or cultural music. Therefore, trainer must be goal oriented and be awake about this.

Educational Attainment Targets

By the end of each key stage, participants are expected to know and apply given skills and attainments in the relevant programme of study.

Key Stage 1- week 1

`The focus of Turkish makam music teaching in key stage 1 is to ensure that participants understand makam music theoretic and syntactical basic foundations via 12 ET system. At this stage people should develop their ability to recognise, describe and can write the specific features of makam music.

Programme of Study for week 1

All courses will be taught for an hour. Therefore, all detailed aims within their minutes are given below. The detailed aims for every course are cover one of each 10 minutes period.

Notes for Course Trainer

- Read the general introduction page of this curriculum file.
- Review and understand the difference between tuning systems' features.
- Examples have given in according to Western concert pitch A. (In Turkish makam music if you would take A as a 440hz it is called Mansur tuning).
- Please do not mention the temperament differences.

Appendix B

General Introduction for Experiment Teachers

Pitch: The term of pitch refers to the frequency of the sound produced when a note corresponding to that pitch is played. Every note in Turkish music has its own name. When reading solfege, the note names are pronounced with common solfege syllables (sol, la, re etc.), while the given names of the notes (e.g., the name of 'D' at 440 Hz. is 'Neva') are used when studying the Turkish makams and note system.

Genus (Cins): The term of Genus has same meaning with the current tetrachord term. Along with intervals, genus are the most fundamental building blocks of Turkish makam music. Most melodies and most cues about a piece (such as scale or makam) are formed by multiple tonal segments.

Makam: A makam is a melodic texture consisting of progressions, directionality, tonal and temporary centres and cadences.

Many music theorists agree on the definition of three types of maqams:

1. Basic (Main or Ana) Maqams,

2. Transposed (Şed or Göçürülmüş) Maqams,

3. Compound (Bileşik) Maqams.

A **Basic maqam** comprises a pentachord joined to the end of a tetrachord (or a tetrachord joined to the end of a pentachord). The dominant is the pitch that lies at the junction point. As a result, each basic maqam consists of 8 pitches, the 8th being the octave of the 1st.

A **Transposed maqam** is one whose scale is the same as another maqam ‘s but starts on a different pitch.

A **Compound maqam** is the combination of two or more maqam ‘s scales.

Usul: An usul is a rhythmic pattern consisting of specific time intervals and accents. Traditionally, usul are practiced by tapping the hands on the knees or beating on a pair of kudum with wooden sticks and verbalizing the beats with syllables like **Dum**, **Tek**, **Te**, **Ke**, etc.

Form: Turkish music can be divided into two main groups based on location of occurrence:

1. Turkish classical music (Cities, towns)

2. Turkish folk music (Rural areas)

Many researchers in the Makam music field have claimed that the two traditions share the same roots, building on

the same pitches, maqams and usuls. Despite differences in instruments, style and notation, the

traditions are of the same essence, according to these researchers.

Turkish music is a genre based on maqam s.

It can be categorized in terms of instrumentation as follows:

1. Instrumental music (Peşrev, Sazsemâisi, etc.)

2. Instrumental - vocal music (Şarkı, Türkü, etc.)

3. Vocal music (Gazel, uzunhava, etc.)

The vocal forms can be subdivided into religious and secular genres.

The Elements of the Turkish Makams

Turkish makam music, in comparison with Western music, a whole step is divided into nine equal steps and a half step is divided into four equal steps. Each of these steps is called a coma; the smallest unit of the Turkish makam music system. The 24-note system (Are-Ezgi-Uzdilek) uses unequal intervals, meaning that the notes used are not divided equally within the octave. This means that not all 9 comas that exist in a whole step are used.

The Tetrachords and Pentachords of Turkish Makam Music

The basic makam scales of Turkish music are constructed by relations of tetrachords and pentachords. However, some of the makam's would be constructed by trichords as well. A tetrachord -except some cases- forms up with 22, and a pentachord forms up with 31 comas. Here is a view of the tetrachords and pentachords that are used for building up the basic makams.

(The given positions of notes are shown by taking A as 440 Hz)

Cadences

Maqam can be roughly defined equivalent of scale; however, it is not a maqam if certain melodic patterns are not emphasized. So, it would be true to say that maqam music, except having tonic and dominant sense, additionally have ruled melodic patterns which give more cognitive and emotional cues. In order to interpret a scale as a makam, cadences are made on certain degrees of the makam's scale. Three types of cadences exist and differentiated by their emphasisings.

In just the same way as Western music, the Turkish makam music is also have similar cadence fact. However, in Western tradition, the meaning of cadences is evolved and also referring more polyphonic features'. In makam music, it should be thought by the momentousness of pitch.

Full Cadence: Namely, final cadence. The first degree of makam.

Half Cadence: In makam music is could be played on the 5^{th} degree or 4^{th} degree of scale.

Suspended Cadence: These are mostly played on the second and the third degrees depending on the structure of the makam. It has an important role on the evolvement of melodic structure and modulations.

Degrees

First Degree: This degree and its function is similar to the tonic degree in Western music. In Turkish language it is called as 'Durak'.

Second and Third Degrees: These degrees are called suspended degrees as well.

Fourth and Fifth Degrees: Depending on the makams' tetrachord and pentachord, usually these two degrees becomes the dominant note.

Sixth Degree: This degree is also behaving as suspended degree. The main difference of this degree in makam music is, it is often used for modulations rather than flavour.

Seventh Degree: The seventh degree of a scale is called the leaading tone (in Turkish 'Yeden'). In the same way as Western tradition, it makes powerful the sense of return to the tonic. In makam music, there are two types of leading tone. If the leading tone is four or five commas below the tonic, it is called a hal step leading tone, if the leading tone is nine commas below the tonic, it is called a whole step leading note.

Eighth Degree: This degree is another important step for the extension of melodic structure. Especially, having relations with suspended degrees, it is used as an important modulation degree. Another function of this degree is it is used also as a dominant note in the makams which have a descending behaviour.

Behaviour (Melodic Direction)

Makam tradition has some rules about melodic direction. For a makam it could be ascending, ascending-descending, descending and descending-ascending. In ascending behaviour, it could start tonic or around tonic. On the other hand, ascending-descending behaviour is usually starting with the dominant note or around the dominant note. As to descending behaviour, the makam begins with the high or around of the high tonic.

Appendix C

Curriculum for Experiment 1

<u>First Period (0-10 Minutes)</u>

- Introduction
- General conversation about the whole training concept and scope.

<u>Second Period (10-20 Minutes)</u>

- *Give the general information about Turkish makam music (from now on will be referred to as Makam music).*
    - Explain the makam and genus meaning.
    - Explain tetrachord and pentachord meaning.
    - Explain and show the accidentals of Hicaz Makam in E
    - Explain the first, fourth and fifth degree.

<u>Third Period (20-30 Minutes)</u>

- *Give the general information about the formation of the makams.*
    - Explain the role of the tetrachord and pentachord (See the appendix 4)
    - Show, play and vocalise the Hicaz tetrachord by doing in the form of ascending, descending and step. (Appendix 2- Figure 1)

- ➢ Show the Rast pentachord (Appendix 2- Figure 2) as same vocalising and piano procedures which has been done in Hicaz tetrachord.

Fourth Period (30-40 Minutes)

- *Give the formation of Hicaz Makam.*

    - ➢ Ensure that participants' understanding about tetrachords and pentachords.
    - ➢ Show the formation, features and accidentals of Hicaz makam and give the relevant information in according to appendix 2.
    - ➢ Practice Hicaz scale and talk about the melodic behaviour which has been given in appendix 2 (as an illustration of melodic behaviour please play the MBEsample 1,2 or 3 from google drive's)
    - ➢ Emphasize unwritten tradition of Hicaz makam's such as naturalization of the sixth degree in any of scale.

Fifth Period (40-50 Minutes)

- *Solfeggio Practices*

    - ➢ Before starting to the solfeggios participants should be entered to target tonality. For this, at first, start with the sequential vocalising of Hicaz makam in company with stressing makam's tonic, dominant, suspended and leading tone degrees.
    - ➢ Practice Hicaz Makam Solfeggio 1. (For means: Google drive→Prepared Solfeggios for Pilot Study→Hicaz Makam Files→Hicaz Equal Temp Solfeggios Pdf Means. For sound files: Google drive→ Prepared Solfeggios for Pilot Study→Hicaz Makam Files→Hicaz Equal Temp Solfeggios Sound Waw files).
    - ➢ Practice Hicaz makam Solfeggio 3.
    - ➢ Practice Hicaz makam solfeggio 4.

Sixth Period (50-60 Minutes)

- *Solfeggio Practices and Completion of Course*
  - Practice Hicaz makam solfeggio 5.
  - Practice Hicaz makam solfeggio 7.
  - Make an epilogue and take feedbacks.

Appendix D

Curriculum for Experiment 2

First Period (0-10 Minutes)

- Introduction
- General conversation about the whole training concept and scope.

Second Period (10-20 Minutes)

- *Give the general information about Turkish makam music (from now on will be referred to as Makam music).*
  - Explain the makam and genus meaning.
  - Explain tetrachord and pentachord meaning.
  - Explain and show the accidentals of Huzzam Makam in F Sharp
  - Explain the tonic, dominant and high dominant degrees of Huzzam Makam.

Third Period (20-30 Minutes)

- *Give the general information about the formation of the makams.*

- ➢ Explain the role of the tetrachord and pentachord (See the appendix 4)
- ➢ Show, play and vocalise the Huzzam pentachord by doing in the form of ascending, descending and step.
- ➢ Show the Hicaz tetrachord as same vocalising and piano procedures which has been done in Huzzam Pentachord.

<u>Fourth Period (30-40 Minutes)</u>

- *Give the formation of Huzzam Makam.*
  - ➢ Ensure that participants' understanding about tetrachords and pentachords.
  - ➢ Show the formation, features and accidentals of Huzzam makam and give the relevant information.
  - ➢ Practice Huzzam scale and talk about the melodic behaviour.
  - ➢ Emphasize unwritten tradition of Huzzam makam's such as naturalization of the sixth degree in any of scale.
  - ➢ Practice Huzzam Makam Solfeggio 1. *(Before starting to the solfeggios participants should be entered to target tonality. For this, at first, start with the sequential vocalising of Hicaz makam in company with stressing makam's tonic, dominant, suspended and leading tone degrees.)*

<u>Fifth Period (40-50 Minutes)</u>

- *Solfeggio Practices*
  - ➢ Practice Huzzam makam Solfeggio 2
  - ➢ Practice Huzzam makam solfeggio 3

<u>Sixth Period (50-60 Minutes)</u>

- *Solfeggio Practices and Completion of Course*

- Practice Huzzam makam solfeggio 4
- Feedbacks for general course structure

Programme of Study for week 2

<u>First Period (0-10 Minutes)</u>

- Introduction
- Q&A session for previous week courses.
- Revisiting of Huzzam Makam components (Tetrachord and Pentachord combination, unwritten rules etc.)

<u>Second Period (10-20 Minutes)</u>

- Re-vocalise Huzzam makam Solfeggio 1
- Re-vocalise Huzzam makam solfeggio 2
- Re-vocalise Huzzam makam Solfeggio 3
- Re-vocalise Huzzam makam solfeggio 4

<u>Third Period (20-30 Minutes)</u>

- Practice Huzzam makam Solfeggio 5
- Practice Huzzam makam solfeggio 6

<u>Fourth Period (30-40 Minutes)</u>

- Practice Huzzam makam Solfeggio 7
- Practice Huzzam makam solfeggio 8

<u>Fifth Period (40-50 Minutes)</u>

- Dictation for Huzzam Makam
- Dictate evaluation.

<u>Sixth Period (50-60 Minutes)</u>

- Feedbacks and evaluations for past two weeks
- Information for next week and Karcigar Makam

Programme of Study for week 3

First Period (0-10 Minutes)

- Introduction
- Explain and show the accidentals of Karcigar Makam in E
- Explain the tonic, dominant and high dominant degrees of Karcigar Makam.

Second Period (10-20 Minutes)

- Show, play and vocalise the Ussak Tetrachord by doing in the form of ascending, descending and step.
- Show the Hicaz Pentachord as same vocalising and piano procedures which has been done in Ussak tetrachord.

Third Period (20-30 Minutes)

- Ensure that participants' understanding about tetrachords and pentachords.
- Show the formation, features and accidentals of Karcigar makam and give the relevant information.
- Practice Karcigar scale and talk about the melodic behaviour.

Fifth Period (40-50 Minutes)

- Practice Karcigar Makam Solfeggio 1. *(Before starting to the solfeggios participants should be entered to target tonality. For this, at first, start with the sequential vocalising of Hicaz makam in company with stressing makam's tonic, dominant, suspended and leading tone degrees.)*

- Practice Karcigar makam Solfeggio 2
- Practice Karcigar makam solfeggio 3

<u>Sixth Period (50-60 Minutes)</u>

- Practice Karcigar Makam Solfeggio 4
- Feedbacks

Programme of Study for week 4

<u>First Period (0-10 Minutes)</u>

- Introduction
- Q&A session for previous week courses.
- Revisiting of Karcigar Makam components (Tetrachord and Pentachord combination, unwritten rules etc.)

<u>Second Period (10-20 Minutes)</u>

- Re-vocalise Karcigar makam Solfeggio 1
- Re-vocalise Karcigar makam solfeggio 2
- Re-vocalise Karcigar makam Solfeggio 3
- Re-vocalise Karcigar makam solfeggio 4

<u>Third Period (20-30 Minutes)</u>

- Practice Karcigar makam Solfeggio 5
- Practice Karcigar makam solfeggio 6

<u>Fourth Period (30-40 Minutes)</u>

- Practice Karcigar makam Solfeggio 7
- Practice Karcigar makam solfeggio 8

<u>Fifth Period (40-50 Minutes)</u>

- 2 Dictation for Karcigar Makam
- Dictation for Huzzam Makam
- Dictate Q&A

<u>Sixth Period (50-60 Minutes)</u>

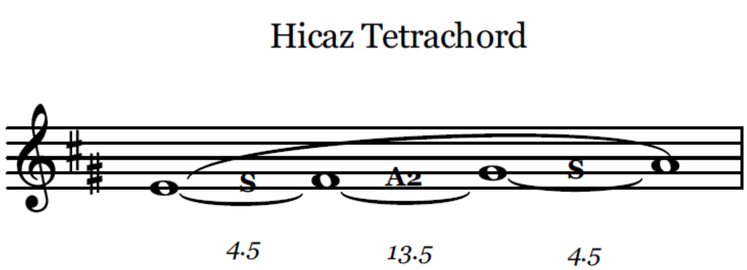
- Feedbacks and evaluations for whole course
- Closure

Appendix E

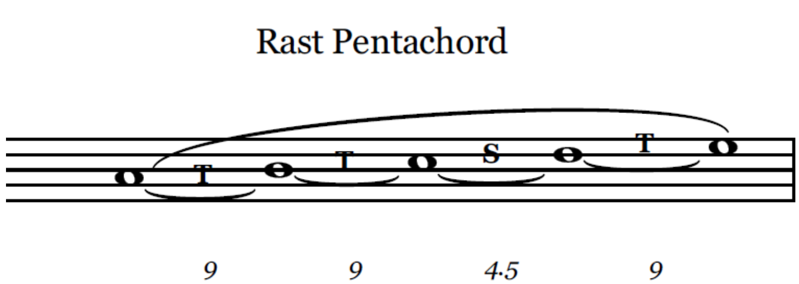
The Features of Ear Training Makams

<u>Hicaz Makam</u>

Hicaz makam is formed by adding a Rast pentachord on top of a Hicaz tetrachord. Hicaz is the name of a makam family including four makams.



Hicaz tetrachord



Rast Pentachord

The Hicaz tetrachord's starting pitch is E note which is also called Huseyni in Turkish (The pitch equivalent in Western tuning is E note).

Tonic : E (Huseyni)

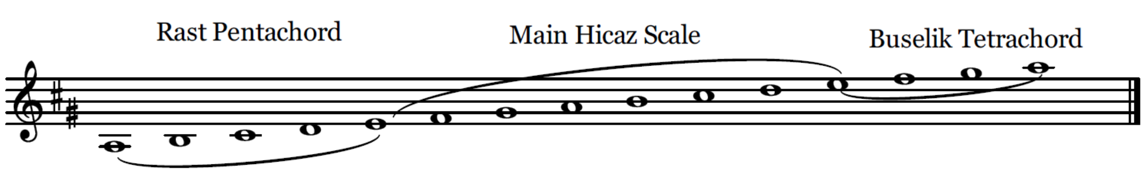
Behaviour : Ascending-descending

Dominant : A (Dugah)

Leading Note : D (Neva)

Accidentals : G Sharp (4.5 Comma) C Sharp(4.5 Comma).

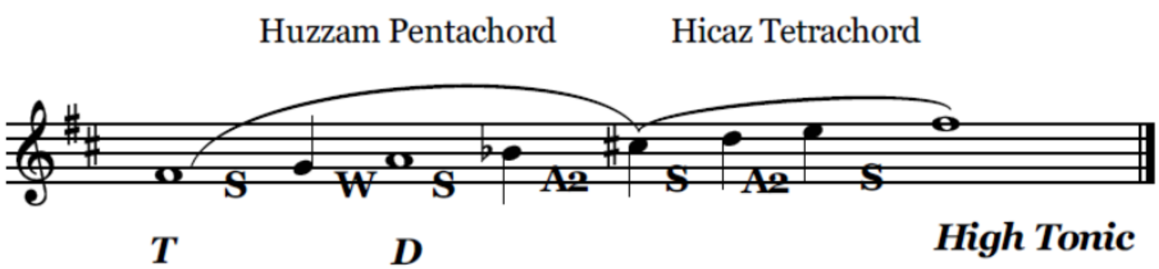
Extension Probabilities: Hicaz makam could be extended either adding a rast pentachord on low register or adding a Buselik tetrachord on high register. See the below figure:



Melodic Progression of Hicaz Makam: Can start around tonic or dominant pitch (A). Usually, after making of mention on Hicaz tetrachord, there could be a half cadence on A after mentioning on rast pentachord. If required, there could be extensions and suspended cadence as well. After emphasizing around E note by using Hicaz tetrachord, it should be finalized on E note. It has become a tradition to use 6th degree in as appeared when ascending and flatten 6th degree when descending.

Huzzam Makam

Huzzam Makam is formed by adding a Hicaz tetrachord on top of Huzzam pentachord.



Huzzam Makam

In this study due to vocalising and tuning equivalency Huzzam Makam's starting note had chosen as F Sharp (The pitching equivalent in the Turkish Makam tuning system is B one coma flat)

Tonic : First Degree

Behaviour : Ascending-descending

Dominant : Third Degree

Leading Note : E Sharp

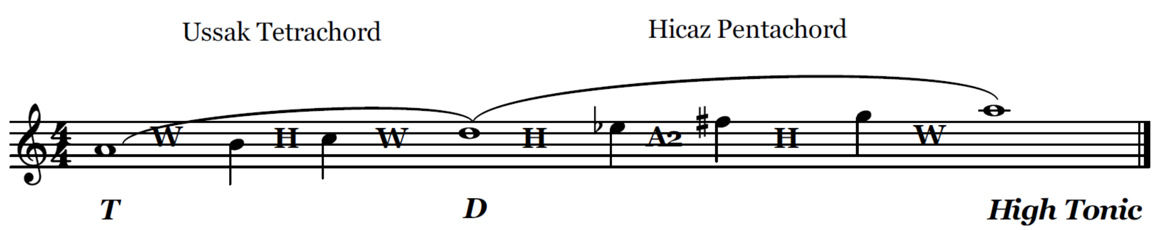
Accidentals: B Flat F Sharp C Sharp

Extension Probabilities: Generally, this makam extends on the low register with Ussak flavour. Sometimes it might also get a Buselik pentachord by starting the sixth degree. (For Buselik tetrachord, please refer to the additional information appendix).

Melodic Progression of Huzzam Makam: Generally, starts with tonic or dominant and emphasise Huzzam pentachord. Suspended cadences might be used on the fifth or fourth degree. Particularly, on descending or ascending melodic movement sometimes F sharp could be naturalised. This is also another important cue of the Huzzam makam.

Karcigar Makam

Karcigar makam is formed by adding a Ussak tetrachord on top of a Hicaz pentachord.



Karcigar Makam

The Karcigar makam's starting pitch is usually A note which is also called Dugah in Turkish (The pitch equivalent in Western tuning is E note).

Tonic : First Degree

Behaviour : Ascending-descending

Dominant : Fourth Degree

Leading Note : G

Accidentals : E flat F sharp if starts on A

Extension Probabilities: In general, another Ussak tetrachord is used for High Tonic extensions. This realisation is usually actualised in ascending behaviour. This behaviour sometimes could be Kurdi tetrachord in descending behaviour. (Please refer Kurdi tetrachord).

Melodic Progression of KarcigarMakam: In general, karcigar makams might start from dominant or tonic. As being an explicit character, it always continues with hicaz pentachords and melodically moves on that pentachord. Melodically, most of karcigar melodic movements contains naturalization of B blat. However, this melodic movement most of the times follows bflat subsequently. In addition to this character, naturalization of F sharp is also another important indicator of Karcigar makam. This movement is always come across on descending fashion.

Appendix F

Cenevre Müzik Duygulanım Ölçeği (CMDÖ-25)

Oylamalarınızı yaparken, lütfen müziğin size nasıl hissettirdiğine odaklanınız (Örneğin; bu Müzik bana üzgün hissettirdi gibi). Müziğin nasıl olduğu ya da müziğin nasıl bir Duygu iletmeye çalıştığını tarif etmeye çalışmayınız. Unutmayın bir Müzik eseri size üzgün hissettirmeden de üzgün duyumsanabilir. Lütfen, oylamanızı aşağıda yer alan Duygu sıfatlarından seçerek ve yoğunluğunu da 1 (hiçbir şekilde) ile 5(çok fazla) arasında uygun gördüğünüz dereceyi baz alarak belirtiniz.

1	**2**	**3**	**4**	**5**
Hiç bir şekilde	Bir Nebze	Kısmen	Yeterince	Çok Fazla

1. ______ İçimi sızlattı
2. ______ Büyüleyici
3. ______ Kuvvetli
4. ______ Narin
5. ______ Geçmişi Hatırlatan
6. ______ Huzurlu
7. ______ Canlı
8. ______ Üzücü
9. ______ Gergin
10. ______ Kıpır Kıpır
11. ______ Hayret Uyandırıcı
12. ______ Duygusal
13. ______ Şefkatli
14. ______ Altında Ezilmek, ezilmiş
15. ______ Kışkırtıcı
16. ______ Ermiş, aşmış
17. ______ Sakinleştirici
18. ______ Sevinçli
19. ______ Ağlamaklı
20. ______ Dinginleştirici
21. ______ Enerjik
22. ______ Hülyalı, rüyada gibi
23. ______ Yumuşatan, mülayimleştiren
24. ______ Cezbedici
25. ______ Muzaffer edalı

Appendix G

Fixed Effects for Verbal Identification rates of Hicaz Makam

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	6.678	1	64	<.01
Temperament System	.018	1	64	.99
Ear Training	<0.001	1	64	.89
Time*Ear Training	<0.001	1	64	.89
Temperament System*Ear Training	<0.001	1	64	.99
Time*Temperament System	.018	1	64	.89
Time*Temperament System*Ear Training	.018	3	33	.89

Appendix H

Fixed Effects for Sublimity Factor Responses to Hicaz Makam (Pre- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	1.189	1	48	.28
Temperament System	1.690	1	48	.20
Ear Training	1.723	1	16.0	.21
Time *Temperament System	0.063	1	48	.80
Time*Ear Training	3.884	1	48	.06
Ear Training*Temperament System	1.801	1	48	.19
Time *Temperament System*EarTraining	.044	1	48	.84

Appendix I

Fixed Effects for Vitality Factor Responses to Hicaz Makam (Pre- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	.005	1	48	.95
Temperament System	74.910	1	48	<.01
Ear Training	2.856	1	16	.11
Time *Temperament System	.077	1	48	.78
Time*Ear Training	.043	1	48	.84
EarTraining*Temperament System	1.386	1	48	.25
Time *Temperament System*EarTraining	.019	1	48	.89

Appendix J

Fixed Effects for Unease Factor Responses to Hicaz Makam (Pre- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	8.889	1	48	<.01
Temperament System	1.800	1	48	.19
Ear Training	.250	1	16	.62
Time * Temperament System	.356	1	48	.55
Time*Ear Training	.200	1	48	.66
EarTraining * Temperament System	.356	1	48	.55
Time * Temperament System * Ear Training	.556	1	48	.46

Appendix K

Fixed Effects for Verbal Identification rates of Karcigar Makam in the UK between Pre-to-Post Experiments

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	154.10	2	28	<.01
Temperament System	<0.001	1	119	.97
Ear Training	1.63	1	27	.21
Time*Ear Training	.85	2	28	.44
Temperament System*Ear Training	.31	1	119	.58
Time*Temperament System	<0.001	2	83	.99
Time*Temperament System*Ear Training	.23	2	83	.80

Appendix L

Fixed Effects for Verbal Identification rates of Huzzam Makam in the UK between Pre-to-Post Experiments

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	27.56	2	156	<.01
Temperament System	.18	1	156	.68
Ear Training	1.39	1	156	.24
Time*Ear Training	1.80	2	156	.17
Temperament System*Ear Training	1.39	1	156	.24
Time*Temperament System	1.78	2	156	.17
Time*Temperament System*Ear Training	1.77	2	156	.17

Appendix M

Fixed Effects for Verbal Identification rates of Karcigar Makam in the TR between Pre-to-Post Experiments

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	144	2	25	<.01
Temperament System	1.26	1	48	.27
Ear Training	1.71	1	23	.20
Time*Ear Training	.86	2	25	.44
Temperament System*Ear Training	<0.001	1	48	.91
Time*Temperament System	.67	2	56	.52
Time*Temperament System*Ear Training	<0.001	2	56	.99

Appendix N

Fixed Effects for Verbal Identification rates of Huzzam Makam in the TR between Pre-to-Post Experiments

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	23.54	2	156	<.01
Temperament System	<0.001	1	156	.94
Ear Training	.10	1	156	.76
Time*Ear Training	.17	2	156	.85
Temperament System*Ear Training	<0.001	1	156	1
Time*Temperament System	<0.001	2	156	.99
Time*Temperament System*Ear Training	<0.001	2	156	1

Appendix O

Fixed Effects for Sublimity Factor Responses to Karcigar Makam in the UK (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*

Time (Pre vs. Mid-Experiment)	.77	1	82	.38
Temperament System	.33	1	82	.57
Ear Training	<0.001	1	26	.99

Appendix P

Fixed Effects for Sublimity Factor Responses to Karcigar Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	<0.001	1	80	.94
Temperament System	<0.001	1	80	.94
Ear Training	2.65	1	26	.11
Time * Temperament System	9.12	1	80	<.01
Time*Ear Training	3.18	1	80	.08

Appendix Q

Fixed Effects for Sublimity Factor Responses to Karcigar Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	24.13	1	52	<.01
Time (Pre vs. Mid-Experiment)	.49	1	160	.48
Temperament System	.22	1	160	.64
Ear Training	.77	1	52	.39
Country*Time	.37	1	160	.55

Country*Ear Training	.71	1	52	.40
Country*Temperament System	.14	1	160	.71
Time*Ear Training	.37	1	160	.55
Time * Temperament System	2.82	1	160	.09
Temperament System*Ear Training	.09	1	160	.77
Country*Time *Temperament System	5.09	1	160	<.05

Appendix R

Fixed Effects for Sublimity Factor Responses to Karcigar Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	2.29	1	81	.13
Temperament System	4.56	1	81	<.05
Ear Training	<0.001	1	26	.84
Time* Temperament System	3.79	1	81	<.05

Appendix S

Fixed Effects for Sublimity Factor Responses to Karcigar Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.12	1	57	.73
Temperament System	11.29	1	57	<.001
Ear Training	<0.001	1	48	.91
Time* Ear Training	8.29	1	48	<.001
Time* Temperament System	9.00	1	57	<.001

Ear Training* Temperament System	2.34	1	60	.13

Appendix T

Fixed Effects for Sublimity Factor Responses to Karcigar Makam (Country-wise comparison between Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	26.69	1	52	<.001
Time (Mid vs. Post-Experiment)	3.02	1	160	.08
Temperament System	8.54	1	160	<.001
Ear Training	.21	1	52	.65
Country*Time	.30	1	160	.58
Country*Ear Training	.64	1	52	.43
Country*Temperament System	.09	1	160	.76
Time*Ear Training	.20	1	160	.65
Time * Temperament System	.40	1	160	.53
Temperament System*Ear Training	.06	1	160	.81
Country*Time *Temperament System	5.33	1	160	<.05

Appendix U

Fixed Effects for Vitality Factor Responses to Karcigar Makam in the UK (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.05	1	81	.82
Temperament System	.22	1	81	.64
Ear Training	.23	1	26	.64

Time* Ear Training	5.99	1	81	<.01

Appendix V

Fixed Effects for Vitality Factor Responses to Karcigar Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	1.58	1	82	.21
Temperament System	<0.001	1	82	.98
Ear Training	1.73	1	26	.20

Appendix W

Fixed Effects for Vitality Factor Responses to Karcigar Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	10.38	1	53	<.001
Time (Pre vs. Mid-Experiment)	.29	1	165	.59
Temperament System	.16	1	165	.72
Ear Training	.13	1	53	.69
Time*Ear Training	7.79	1	165	<.001

Appendix X

Fixed Effects for Vitality Factor Responses to Karcigar Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*

Time (Mid vs. Post-Experiment)	.07	1	81	.79
Temperament System	.39	1	81	.53
Ear Training	.11	1	26	.74
Time* Ear Training	5.69	1	81	<.01

Appendix Y

Fixed Effects for Vitality Factor Responses to Karcigar Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.02	1	78	.89
Temperament System	.26	1	78	.61
Ear Training	2.95	1	26	.10
Time* Ear Training	.45	1	78	.50
Time*Temperament System	.16	1	78	.69
Ear Training*Temperament System	.45	1	78	.50
Time*Ear Training*Temperament System	5.46	1	78	<.05

Appendix Z

Fixed Effects for Vitality Factor Responses to Karcigar Makam (Country-wise comparison between Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*

Country	11.76	1	52	<.001
Time (Mid vs. Post-Experiment)	.09	1	156	.77
Temperament System	.06	1	156	.81
Ear Training	.47	1	52	.50
Country*Time	.02	1	156	.88
Country*Ear Training	1.53	1	52	.22
Country*Temperament System	.65	1	156	.42
Time*Ear Training	5.58	1	156	<.05
Time * Temperament System	1.98	1	156	.16
Temperament System*Ear Training	.15	1	156	.70
Country*Time *Ear Training	2.61	1	156	.11
Country*Time *Temperament System	.92	1	156	.34
Country*Ear Training*Temperament System	1.29	1	156	.26
Time*Ear Training*Temperament System	.43	1	156	.51
Country*Time*Ear Training*Temperament System	3.78	1	156	<.05

Appendix AA

Fixed Effects for Unease Factor Responses to Karcigar Makam in the UK (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*

Time (Pre vs. Mid-Experiment)	<0.001	1	78	.93
Temperament System	.20	1	78	.66
Ear Training	.16	1	26	.69
Time* Ear Training	2.57	1	78	.11
Time* Temperament System	1.14	1	78	.29
Ear Training*Temperament System	.13	1	78	.72
Time* Ear Training*Temperament System	4.96	1	78	<.05

Appendix AB

Fixed Effects for Unease Factor Responses to Karcigar Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.08	1	82	.77
Temperament System	<0.001	1	82	.95
Ear Training	.10	1	26	.76

Appendix AC

Fixed Effects for Unease Factor Responses to Karcigar Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	11.93	1	52	<.001
Time (Pre vs. Mid-Experiment)	.06	1	156	.80
Temperament System	.15	1	156	.70
Ear Training	.25	1	52	.62
Country*Time	.01	1	156	.92
Country*Ear Training	.04	1	52	.83
Country*Temperament System	.10	1	156	.75

Time*Ear Training	.46	1	156	.50
Time * Temperament System	.37	1	156	.55
Temperament System*Ear Training	1.06	1	156	.30
Country*Time *Ear Training	3.55	1	156	.06
Country*Time *Temperament System	1.22	1	156	.27
Country*Ear Training*Temperament System	.21	1	156	.65
Time*Ear Training*Temperament System	1.22	1	156	.27
Country*Time*Ear Training*Temperament System	6.02	1	156	<.05

Appendix AD

Fixed Effects for Unease Factor Responses to Karcigar Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.04	1	78	.84
Temperament System	.03	1	78	.86
Ear Training	.25	1	26	.62
Time* Temperament System	1.98	1	78	.16
Ear Training*Temperament System	5.06	1	78	<.05

Appendix AE

Fixed Effects for Unease Factor Responses to Karcigar Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	3.18	1	82	.08
Temperament System	.30	1	82	.87
Ear Training	.03	1	26	.59

Appendix AF

Fixed Effects for Unease Factor Responses to Karcigar Makam (Country-wise comparison between Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	16.49	1	53	<.001
Time (Mid vs. Post-Experiment)	.57	1	166	.45
Temperament System	.03	1	166	.86
Ear Training	.14	1	53	.71

Appendix AG

Fixed Effects for Sublimity Factor Responses to Huzzam Makam in the UK (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.45	1	78	.51
Temperament System	.60	1	78	.44
Ear Training	.17	1	26	.68
Time*Ear Training	3.45	1	78	.07
Time * Temperament System	.06	1	78	.82
Ear Training*Temperament System	.35	1	78	.55
Time*Ear Training*Temperament System	4.61	1	78	<.05

Appendix AH

Fixed Effects for Sublimity Factor Responses to Huzzam Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.12	1	82	.73
Temperament System	1.12	1	82	.29
Ear Training	4.58	1	26	<.05

Appendix AI

Fixed Effects for Sublimity Factor Responses to Huzzam Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	4.99	1	52	<.05
Time (Pre vs. Mid-Experiment)	.01	1	160	.92
Temperament System	.17	1	160	.68
Ear Training	.57	1	52	.46
Country*Time	.44	1	160	.51
Country*Ear Training	2.14	1	52	.15
Country*Temperament System	1.70	1	160	.20
Time*Ear Training	.72	1	160	.40
Time * Temperament System	.04	1	160	.85
Temperament System*Ear Training	.25	1	160	.62
Time *Ear Training*Temperament System	3.69	1	160	<.05

Appendix AJ

Fixed Effects for Sublimity Factor Responses to Huzzam Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	<0.001	1	80	.94
Temperament System	3.09	1	80	.08
Ear Training	.13	1	26	.73
Ear Training* Temperament System	5.74	1	80	<.05

Appendix AK

Fixed Effects for Sublimity Factor Responses to Huzzam Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	1.67	1	82	.20
Temperament System	1.53	1	82	.22
Ear Training	2.15	1	26	.16

Appendix AL

Fixed Effects for Sublimity Factor Responses to Huzzam Makam (Country-wise comparison between Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	6.83	1	53	<.01
Time (Mid vs. Post-Experiment)	.98	1	165	.32
Temperament System	<0.001	1	165	.99
Ear Training	.25	1	53	.62
Country*Temperament System	3.97	1	165	<.05

Appendix AM

Fixed Effects for Vitality Factor Responses to Huzzam Makam in the UK (Pre- and Mid-

Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.47	1	41	.50
Temperament System	.19	1	65	.67
Ear Training	4.87	1	26	<.05
Time* Ear Training	4.38	1	41	<.05

Appendix AN

Fixed Effects for Vitality Factor Responses to Huzzam Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	<0.001	1	44	.96
Temperament System	.78	1	44	.38
Ear Training	1.16	1	26	.29
Time* Ear Training	2.90	1	44	.10
Time*Temperament System	.49	1	38	.49
Ear Training*Temperament System	4.36	1	44	<.05
Time*Ear Training*Temperament System	7.82	1	38	<.01

Appendix AO

Fixed Effects for Vitality Factor Responses to Huzzam Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	8.02	1	53	<.01
Time (Pre vs. Mid-Experiment)	.11	1	166	.74
Temperament System	.04	1	166	.84

Ear Training	<0.001	1	53	.98

Appendix AP

Fixed Effects for Vitality Factor Responses to Huzzam Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	3.85	1	81	<.05
Temperament System	.20	1	81	.66
Ear Training	.06	1	26	.80

Appendix AQ

Fixed Effects for Vitality Factor Responses to Huzzam Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.31	1	80	.58
Temperament System	.51	1	80	.48
Ear Training	1.20	1	26	.28
Time* Ear Training	1.62	1	80	.21
Ear Training*Temperament System	3.64	1	80	<.05

Appendix AR

Fixed Effects for Vitality Factor Responses to Huzzam Makam (Country-wise comparison *between Mid- and Post-Experiment)*

Variable	*F*	*df1*	*df2*	*p*
Country	13.60	1	52	<.001
Time (Mid vs. Post-Experiment)	.78	1	161	.38
Temperament System	.06	1	161	.81
Ear Training	.24	1	52	.63
Country*Time	2.93	1	161	.09
Country*Ear Training	.77	1	52	.38
Country*Temperament System	.68	1	161	.41
Time*Ear Training	.01	1	161	.93
Temperament System*Ear Training	2.27	1	161	.13
Country*Time *Ear Training	3.91	1	161	<.05

Appendix AS

Fixed Effects for Unease Factor Responses to Huzzam Makam in the UK (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	.03	1	102	.86
Temperament System	.01	1	102	.92
Ear Training	.03	1	102	.85
Time* Ear Training	1.39	1	102	.24
Time* Temperament System	.68	1	102	.41
Ear Training*Temperament System	23.30	1	102	<.001
Time* Ear Training*Temperament System	4.91	1	102	<.05

Appendix AT

Fixed Effects for Unease Factor Responses to Huzzam Makam in the TR (Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Mid-Experiment)	3.84	1	82	<.05
Temperament System	.30	1	82	.59
Ear Training	<0.001	1	26	.95

Appendix AU

Fixed Effects for Unease Factor Responses to Huzzam Makam (Country-wise comparison between Pre- and Mid-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	12.06	1	53	<.001
Time (Pre vs. Mid-Experiment)	2.52	1	166	.11
Temperament System	<0.001	1	166	.97
Ear Training	.20	1	53	.66

Appendix AV

Fixed Effects for Unease Factor Responses to Huzzam Makam in the UK (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.83	1	82	.37
Temperament System	.50	1	82	.48
Ear Training	.01	1	26	.94

Appendix AW

Fixed Effects for Unease Factor Responses to Huzzam Makam in the TR (Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Mid vs. Post-Experiment)	.07	1	82	.78
Temperament System	.31	1	82	.58
Ear Training	.02	1	26	.90

Appendix AX

Fixed Effects for Unease Factor Responses to Huzzam Makam (Country-wise comparison between Mid- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Country	19.11	1	53	<.001
Time (Mid vs. Post-Experiment)	.33	1	166	.57
Temperament System	.06	1	166	.81
Ear Training	<0.001	1	53	1

Appendix AY

Note: Asteriks are represent the position of probes.

Hicaz:

Boğaziçi Şen Gönüller Yatağı

Hicaz Şarkı

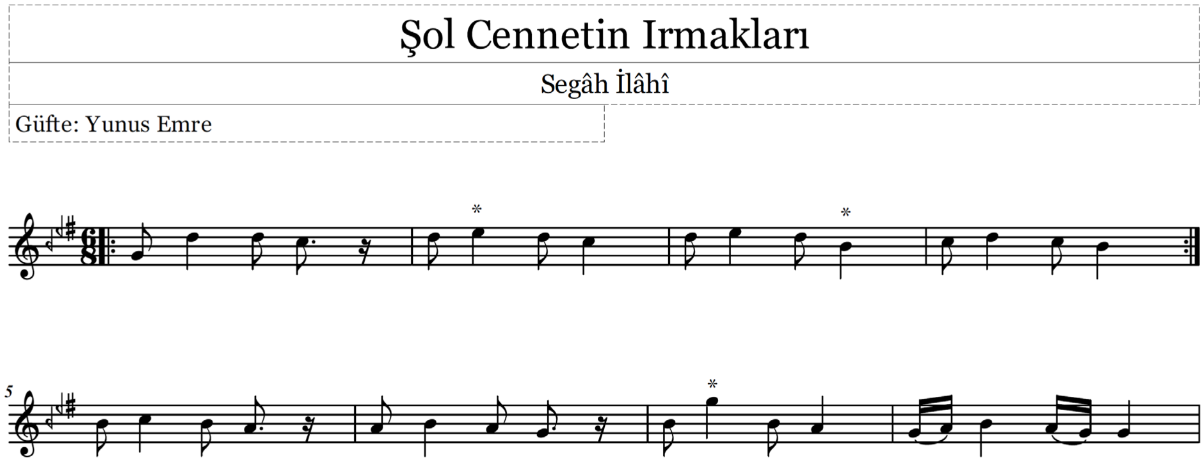
Güfte: Alâeddin Yavaşca | Beste: Alâeddin Yavaşca

Huzzam:

Hüzzam Peşrev

Beste: Tanburî Büyük Osman Bey

Segah:



Appendix AZ

Fixed Effects for 'goodness-of-fit' Means to M6 in Huzzam Makam (Pre- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	2.48	3	64	.07
Temperament System	6.71	1	64	<.01
Ear Training	.26	1	64	.62

Appendix BA

Fixed Effects for 'goodness-of-fit' Means to M2 in Huzzam Makam (Pre- and Post-Experiment)

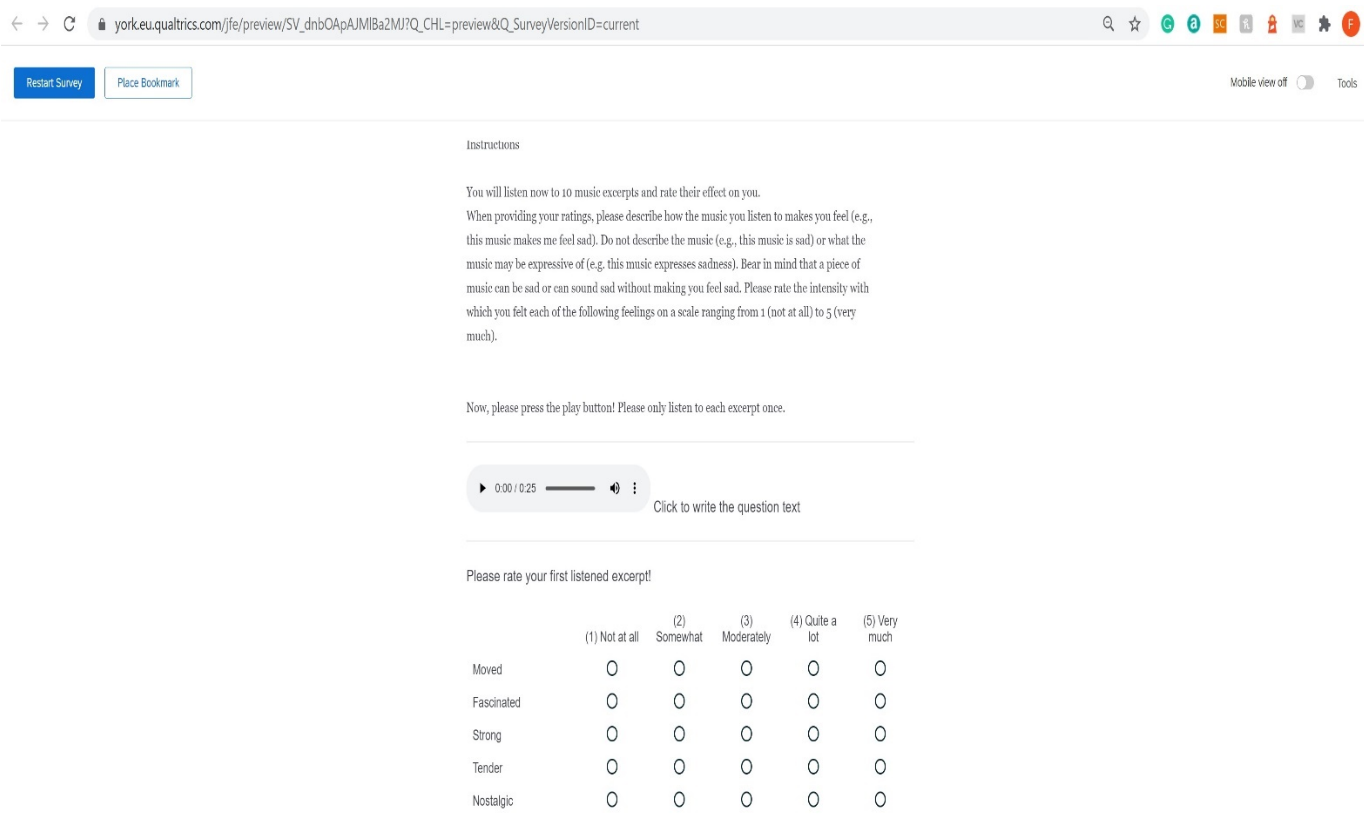
Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	2.90	1	62	.09
Temperament System	39.84	1	62	<.001
Ear Training	1.26	1	62	.27
Time*Ear Training	3.48	1	62	.07
Time*Temperament System	8.05	1	62	<.01

Appendix BB

Fixed Effects for 'goodness-of-fit' Means to M2 in Huzzam Makam (Pre- and Post-Experiment)

Variable	*F*	*df1*	*df2*	*p*
Time (Pre vs. Post-Experiment)	.07	1	60	.79
Temperament System	3.58	1	60	.06
Ear Training	1.43	1	60	.24

Appendix BC



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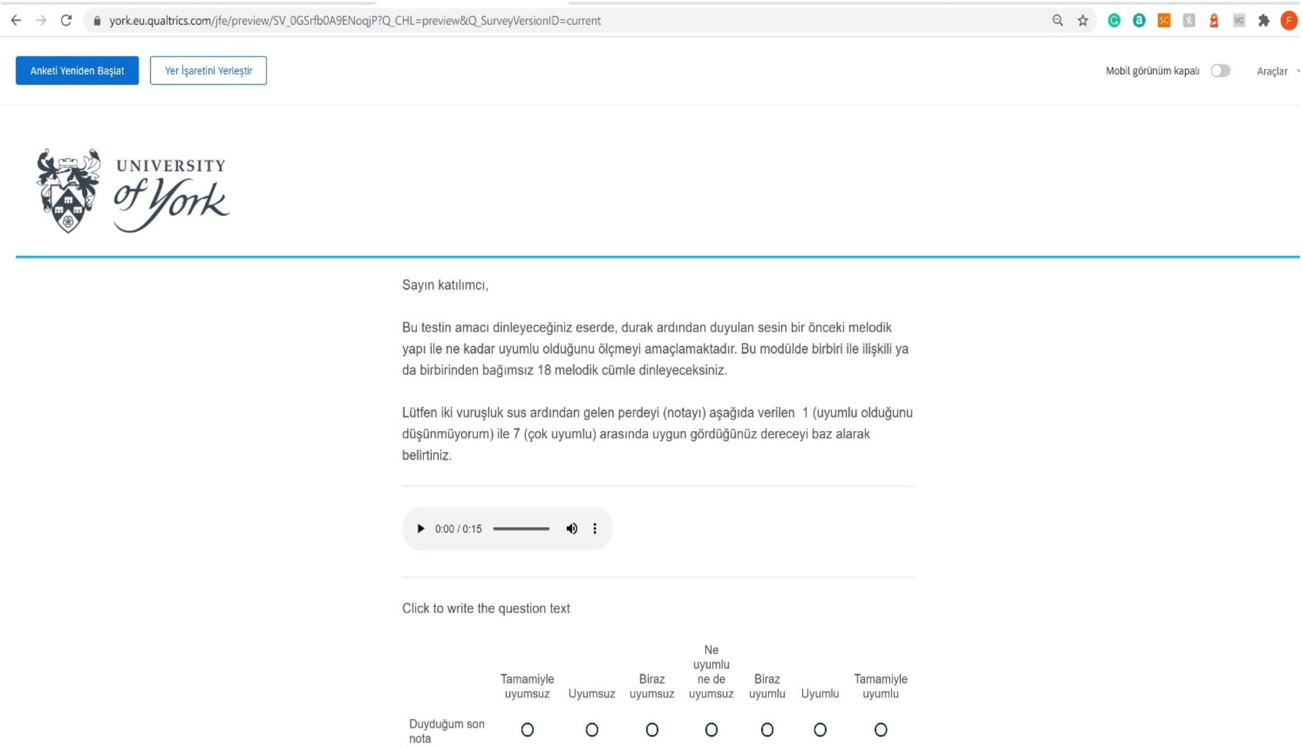
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Anketi Yeniden Başlat | Yer İşaretini Yerleştir

Mobil görünüm kapalı | Araçlar

UNIVERSITY of York

Sayın katılımcı,

Bu testin amacı dinleyeceğiniz eserde, durak ardından duyulan sesin bir önceki melodik yapı ile ne kadar uyumlu olduğunu ölçmeyi amaçlamaktadır. Bu modülde birbiri ile ilişkili ya da birbirinden bağımsız 18 melodik cümle dinleyeceksiniz.

Lütfen iki vuruşluk sus ardından gelen perdeyi (notayı) aşağıda verilen 1 (uyumlu olduğunu düşünmüyorum) ile 7 (çok uyumlu) arasında uygun gördüğünüz dereceyi baz alarak belirtiniz.

0:00 / 0:15

Click to write the question text

	Tamamiyle uyumsuz	Uyumsuz	Biraz uyumsuz	Ne uyumlu ne de uyumsuz	Biraz uyumlu	Uyumlu	Tamamiyle uyumlu
Duyduğum son nota	O	O	O	O	O	O	O

Appendix BE

24 OT Hicaz Makam Solfeggio 1

24 OT Hicaz Makam Solfeggio 2

24 OT Hicaz Makam Solfeggio 3

24 OT Hicaz Makam Solfeggio 4

24 OT Hicaz Makam Solfeggio 5

24 OT Hicaz Makam Solfeggio 6

24 OT Hicaz Makam Solfeggio 7

24 OT Hicaz Makam Solfeggio 8

24 OT Huzzam Makam Solfeggio 1

24 OT Huzzam Makam Solfeggio 2

24 OT Huzzam Makam Solfeggio 3

24 OT Huzzam Makam Solfeggio 4

24 OT Huzzam Makam Solfeggio 5

24 OT Huzzam Makam Solfeggio 6

24 OT Huzzam Makam Solfeggio 7

24 OT Huzzam Makam Solfeggio 8

24 OT Karcigar Solfeggio 1

24 OT Karcigar Solfeggio 2

24 OT Karcigar Solfeggio 3

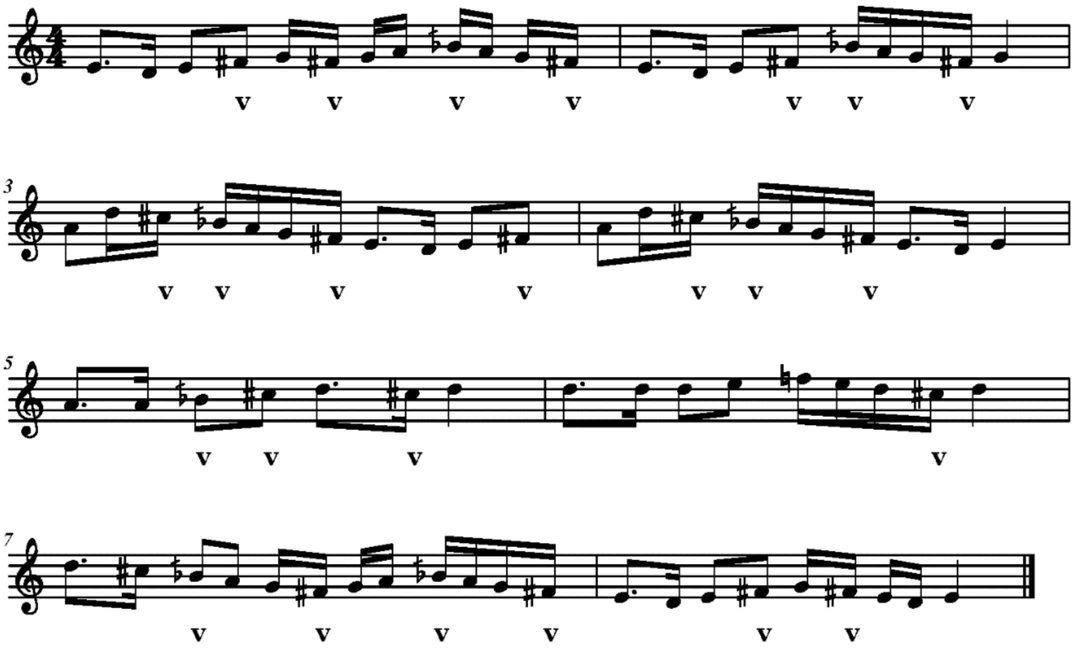
24 OT Karcigar Solfeggio 4

24 OT Karcigar Solfeggio 5

24 OT Karcigar Solfeggio 6

24 OT Karcigar Solfeggio 7

24 OT Karcigar Solfeggio 8



12 ET Hicaz Makam Solfeggio 1

12 ET Hicaz Makam Solfeggio 2

12 ET Hicaz Makam Solfeggio 3

12 ET Hicaz Makam Solfeggio 4

12 ET Hicaz Makam Solfeggio 5

12 ET Hicaz Makam Solfeggio 6

12 ET Hicaz Makam Solfeggio 7

12 ET Hicaz Makam Solfeggio 7

12 ET Huzzam Makam Solfeggio 1

12 ET Huzzam Makam Solfeggio 2

12 ET Huzzam Makam Solfeggio 3

12 ET Huzzam Makam Solfeggio 4

12 ET Huzzam Makam Solfeggio 5

12 ET Huzzam Makam Solfeggio 6

12 ET Huzzam Makam Solfeggio 7

12 ET Huzzam Makam Solfeggio 8

12 ET Karcigar Solfeggio 1

12 ET Karcigar Solfeggio 2

12 ET Karcigar Solfeggio 3

12 ET Karcigar Solfeggio 4

12 ET Karcigar Solfeggio 5

12 ET Karcigar Solfeggio 6

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12 ET Karcigar Solfeggio 8