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An Embodied Perspective on Piano Timbre: Conceptualisation and Communication in Performance and Educational Context.

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I hereby declare that this submission is my own work and it does not contain any materials previously published or written by another person. In particular, this thesis contains entirely or parts of the following publications of mine:

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Abstract

This thesis presents three empirical studies which explore the conceptualisation and communication of piano timbre from the perspective of the performer, the listener, and the pairing of teacher and student. The research started from the perspective of the debate between acousticians and musicians on touch-tone relationships, with the conviction that piano timbre should not be only concerned with the examination of sonic outcomes, but should aim to understand the phenomenology of experiences and conceptions related to piano timbre. Less is known about what contributes to the conceptualisation of piano timbre in terms of metaphor, cross-modal experience, mental images etc.; whether, and how, a timbral intention in piano performance can be communicated to others via sound and/or the body. By adopting an embodied perspective, this research has focused on an exploration of sound-gesture relationships in the perception and production of piano timbre, using a mix of qualitative and quantitative approaches. The first interview study indicated that expressive gestures and the introspective experience of performers affect the way they perceive and describe piano timbre. The second study examined the embodiment of piano timbre and demonstrated through a perceptual experiment that the visual component of piano performance influences the perceived timbral experience of listeners. The communication of piano timbre is multimodal and integrates aspects from visual, tactile, kinaesthetic and sonic dimensions. The third teaching observation study implied that shared understanding of piano timbre is an emergent and enactive product in a piano lesson through the real-time collaboration and participation of both the teacher and the student. The whole thesis contributes to the understanding of embodied music cognition and has implications for expressive piano performance and teaching practice.

Keywords: piano timbre, embodied music cognition, metaphor, musical gestures, multimodal perception, action-perception coupling, piano teaching and learning;

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Chapter 1: Introduction

1.1 Research Background and Scope

The notion of timbre investigated in this thesis is slightly different from the traditional scope of timbre studies in which timbre is seen as one of the most effective devices for performers to adjust their sound palette in a musical performance in addition to the utilisation of timing, dynamics, and articulation (e.g. Nykänen & Johansson, 2003; Stepánek, 2006). Spectral changes of the sound associated with changes in timbre can be very significant: for example, singers adjust their vocal tract or change the mouth shape to produce a variety of vocal timbres (Prem & Parncutt, 2007), whilst guitarists change the plucking position on the bridge as well as the angle of the finger/nail to achieve varying timbral qualities (Traube, 2004). On the contrary, the notion of piano timbre in this thesis is not focussed on an investigation of spectral evidence; instead it will explore the beliefs of pianists about piano timbre and present several pieces of empirical evidence of the ways in which pianists communicate and mobilise timbre in their musical practices, which go considerably beyond spectral changes. Given the restricted variation possibilities of sound colour on a piano, the notion of timbre in this study will embrace attributes such as articulation, intensity, and melody which typically are not included in the definition of timbre, but is related to pianists' own accounts of piano timbre. In short, this study is mainly concerned with the way that pianists describe, conceptualise, and experience the intended/performed timbral qualities.

As a performer myself, I was told, taught, and also experienced the fact that the variety of timbral nuances provided by the piano is relatively limited compared to other instruments like voice and guitar. Indeed, acousticians hold to the scientific fact that it is hard to change the quality of timbre independently of other performance parameters including timing, dynamics, and articulation, and they have tried to convince pianists of the importance of their findings by conducting systematic examinations through sound analysis (Goebl, Bresin, & Fujinaga, 2014; Goebl, Bresin, & Galembo, 2005; Suzuki, 2007). However, this does not deter pianists from

exploring sound possibilities on the piano. They have hundreds of adjective descriptors to describe perceived timbral qualities (Bellemere & Traube, 2005); they believe that they are able to imitate and produce orchestral sounds on the piano, and have trained themselves to produce these timbres with advanced motor skills such as touch types, bodily coordination, weight control and muscular relaxation/contraction etc. (Neuhaus, 1993; MacRitchie, 2015). The conflicting views of musicians and scientists is at the root of my research interest, and I was keen to explore the questions: Do timbral variations exist on the piano? How do pianists conceptualise the notion of piano timbre?

As I went further, I started to be curious about the communication of timbral effects in piano performance from the perspective of a listener, and to think about implications in the wider educational context. As audiences, what do we perceive in the timbral qualities of a piano performance? However, the majority of studies are concerned with emotional communication and expression in music performance (Laukka, Eerola, Thingujam, & Yamasaki, 2013), and little is known in terms of whether, and how, expressive intentions related to timbre are communicated between pianists and listeners. In fact, apart from the felt and perceived emotions and moods, our perceptions in relation to timbral intentions and qualities in a piano performance have been demonstrated to be rich in language and concepts. We evaluate the timbre technically (pressed or struck), perceptually (bright, dark), and aesthetically (good or bad) (Kojucharov & Rodà, 2015). Additionally, as a part-time piano teacher myself, I have experienced the difficulties and challenges of communicating a timbre concept to young students; for instance what is a 'round' timbre? What do I mean by 'timbre' itself in addition to the loudness or softness of the sound? How can a 'violin' sound be produced on the piano? These are the questions that have driven me to go deeper into my research – to explore aspects of the communication, expression and learning of piano timbre.

The above statements aim to depict a holistic picture of the perception and production of piano timbre, consisting of the following elements of the mind, the body, sounds, the instrument,

the multisensory modality, and the context. This thesis aims to investigate piano timbre: 1) By exploring the psychological and physiological aspects of timbre to explain the perception and production of piano timbre; 2) By explaining the process and the results regarding how various aspects of the sound, the movement, the concept, and the language are connected and influenced by each other; 3) From multiple perspectives that include the performer, the listener, and the music teachers and students.

It is also necessary to point out what my thesis will not include. Firstly, I am not interested in the differences/similarities of piano timbre produced from a variety of pianos – the so-called macro-perspective of timbre (e.g. Cheminée, Gherghinoiu, & Besnainou, 2005). To my knowledge, the majority of timbre studies focus on such macro-perspectives (McAdams, 1993; Handel, 1995), but studies of timbre produced from one singular instrument are relatively rare: dedicated empirical research has only been done recently with respect to the clarinet (Barthet, Depalle, Kronland-Martinet, & Ystad, 2010), the guitar (Traube, 2004), and the piano (Bernays, 2013). Secondly, I am not focusing on the acoustic examination of piano timbre, because what is of more interest to me are the psychological and philosophical issues relating to the perception and production of piano timbre. Thirdly, this thesis does not consider the historical aspect of piano performance (e.g. historical style, period, technique schools etc.) and its influences on the conceptualisation and teaching/learning of piano timbre, but rather, focuses on classical music performance and education. The whole thesis is more exploratory, and the arguments are based on empirical findings from interviews, an experiment, and observations.

1.2 Main Research Questions

The research questions that are explored in this thesis include four main research questions and several sub-questions that are covered in each cluster of main questions.

Q1: How is the notion of piano timbre conceptualised?

Q2: How do pianists understand the notion of piano timbre?

Q3: How is timbre referred to in a piano lesson?

Q4: How is piano timbre communicated?

Q5: Do pianists communicate timbral intentions to the audience and is the communication reliable?

Q6: What do listeners perceive in the communication of timbral intention in a piano performance?

Q7: What is the relevance of the auditory and/or visual component of musical performance in timbre communication?

Q8: How is piano timbre taught and learnt?

Q9: How is the process like in a piano lesson, in terms of time allocation and teacher-student behaviours?

Q10: How do different teaching strategies work together to facilitate the communication process?

Q11: What is the relationship between body and mind in the perception and production of piano timbre?

1.3 Thesis Structure

This thesis contains four theoretical considerations and three empirical studies related to piano timbre, which forms ten chapters as a whole. The theoretical chapters start from the second chapter, which introduces the origins of the research, existing research on piano timbre, and the relevant research gaps (Chapter 2). This is followed by an explanation of an embodied perspective of piano timbre which addresses the issue of how to connect sound with the mind, the body, the instrument, and language in the study of piano timbre (Chapter 3). Chapter 4 is concerned with the production of timbral effects in a piano performance, and is discussed from the perspective of a communication model between the pianist and the audience, considering the influence of visual-auditory feedback and the role of cross-modal associations in the perception of piano timbre.

Chapter 5 considers the teaching and learning of piano timbre in a higher education context, investigating the skills and teaching strategies utilised in the acquisition of the knowledge of piano timbre.

Following the theoretical framework of the study of piano timbre, three empirical studies are presented: an interview study, a perceptual experiment, and a teaching observation study. Chapter 6 presents an overall picture of the methodology adopted in this thesis, and explains the research design and methods of each individual study. The findings of each empirical study are introduced from Chapter 7 onwards. In relation to the research questions, Chapter 7 is concerned with the inner world of the performer when producing timbral qualities, and reveals how piano timbre is conceptualised and approached and to what extent timbre concepts are related to musical interpretations and expression. Chapter 8 examines what listeners perceive in the communication of piano timbre and how a timbral intention can be communicated via sound and/or body. Chapter 9 concerns the making of piano timbre in a live situation where knowledge exchange and interaction between a teacher and student take place in an enacted and real-time manner. Chapter 10 summarises the main arguments, findings, contributions, and limitations of the whole thesis.

Chapter 2: Traditional Perspectives in Piano Timbre Studies

'To the general listener, pitch and loudness are variable characteristics of sound, timbre is a condition; pitch and loudness are things a sound does, timbre is what a sound is.' (p. 58)

-- Fales (2002)

2.1 Contrasting Opinions of the Impact of Touch on Tone Quality

2.1.1 The view of acousticians

Scientific research into piano playing and piano pedagogy began in 1925 with Ortmann's remarkable work, *The Physical Basis of Piano Touch and Tone*. One of the most striking arguments made by Ortmann is that pianists cannot vary piano timbre without changing the dynamics-- a specific degree of intensity is always associated with only one tone quality (1925; 1935). Since then, the touch-tone relationship[1], and whether piano timbre can be varied by applying different qualities of touch without changing other musical features, has become a topic of hot debate between acousticians and musicians. Professor Carl Seashore, a pioneer in the psychology of music, published an article about piano touch in *The Scientific Monthly* (1937) which appraised the value of Ortmann's scientific approach to the study of touch-tone relationships. He emphasized two performative elements, namely intensity and time, and argued that pianists rely on these to vary tone quality aside from pedal use and attack noise. Turner (1939) made a similar argument by stating that independent control over tone quality is non-existent and that: 'apart from the minor question of finger and action noise, tone quality is not influenced in the least by the form of touch you employ.' (p. 175). It is acknowledged that, in spite of the date of these studies, they have continued to be influential in the study of piano tone production and have led to

[1] I will use the phrase of 'touch-tone relationship' consistently in the rest of the thesis, to refer to the relationship between piano touch and tone quality.

heated debates on the touch-tone relationship in subsequent psychoacoustic studies of piano timbre (more detail on this will be found in Section 2.3.1).

Acousticians conduct such scientific and careful examinations on piano sounds for certain reasons; they aim to objectively determine their findings and persuade musicians to use these ideas on the touch-tone relationship in performance. As Seashore (1937) stated:

> The artist may legitimately think and perform with tone quality as his objective, and consciously control his touch in terms of tone quality. Likewise the listeners may regard tone quality as the primary factor and think of intensity as a secondary and even unrelated factor. But the fact remains that, in general, the only way in which the pianist can produce qualitative changes is through dynamic and temporal changes, and then only within limits set by the characteristics of the instrument. (p. 365)

2.1.2 The perspective of musicians

Unlike acousticians and scientists, whose main concern is the timbral qualities of a single tone, musicians are concerned with the production of timbral nuances in a polyphonic and melodic context. The employment of different touch types becomes their main tool to achieve the required variety of tone colour (MacRitchie, 2015; Berman, 2002; Parncutt & Troup, 2002).

Pianists and scholars have explained different types of piano touch: MacRitchie (2015) conducted a systematic review of piano touch, and related biomechanical knowledge to piano performance. Her research considered the individual difference (e.g. hand anthropometry, difference in training etc.) in the choice and utilisation of touch types, and suggested an effective and scientific way of achieving an expressive musical performance while minimising the risk of injury. Berman (2002) summarised several crucial aspects of piano touch, including: weight (how much weight is applied to the key); mass (how much of the body is involved in the keypress); speed (of the keypress); perception of depth (comparison of deep or shallow touch); shape of the fingers (curvature, amount and location of contact on the pad or fingertip), and *in* or *out*: ‘in

(pouring weight into each note)' and 'out' (pulling the fingers away from the keys, '…as if grabbing the sound from the keyboard and bringing it out.' (p. 6) McPherson and Kim (2011) added to this idea by including the elements of rigidity and percussiveness to touch qualities: Percussiveness refers to the finger-striking pattern, whether it is a stroking motion with fingers resting on the keyboard (i.e. non-percussive), or from very high space (i.e. percussive) in order to generate loud and forceful sounds. Rigidity refers to the level of muscle tension when playing percussive notes – whether the key is held with loose or tight hands.

Lhévinne (2013) in his well-known book *Basic Principles in Piano Playing* mentioned the influence of the size of the fingertip contact on the keyboard on the produced tone. The author suggested that a small striking surface which uses only the tip of the finger will produce a brilliant, brittle tone; a larger surface using a flatter finger, will produce a more ringing and singing the tone. Parncutt and Troup (2002) also mentioned the difference between curved and straight fingers and their relationship with dynamic level: Curved fingers are suitable for playing loud, scale-like passages; straight fingers are preferred in softer, slower, single-line melodies (a larger skin area being involved to touch the surface of the key).

It is acknowledged, however, that the type of touch is only one of the performative elements that pianists utilise to make timbral effects. The control of bodily aspects also seems to be crucial in piano performance, for instance: bodily tension and relaxation, weight and energy, and finger-arm coordination. These factors will be explained with more details in Chapter 5, which examines the learning and teaching of piano timbre in a pedagogical context.

2.1.3 The conflict

The acoustical perspective of timbre production has challenged pianists' views on the touch-tone relationship. However, do pianists tend to neglect scientific findings on tone production, continuing to pay more attention to more artistic views and manners? The answer is, apparently, no. World-class pianist Charles Rosen (2002) has clarified: 'Inside the piano, the elaborate

arrangement of joints and springs will only cause the hammer to hit the strings with greater or lesser force.' (p. 24). Joszef Gát in his book the technique of piano playing which was translated and published in 1974 strongly indicated that, even though the experiments conducted on the piano touch-tone relationship may not be incorrect, they cannot be accepted as the only truth, since piano playing cannot only be explained rationally. Hamilton explained the physical mechanism of tone production on the piano (2012):

> For this hammer stroke, the direct propelling power lies in the key-lever, which may be depressed at its outer end by the player's finger only about three-eighths of an inch. During this key-depression the hammer is rising at a much more rapid rate, until it arrives at a point near the string, when the motive power of the key stops…the hammer is thus left to fly the rest of the way to the string, actuated by the momentum already imparted to it…it means that the really effective part of the hammer stroke is actually without the control of the player. (p. 31)

The above pianists' statements on tone production demonstrate that not all pianists are blind to the scientific views on the absence of a touch-tone relationship; instead they clearly understand the mechanical limitations on the production of tone quality. In my research, I aim to clarify why musicians hold distinct perspectives on timbre, not because they neglect the scientific and empirical research results, but rather, because they are aware of this knowledge, they can adjust their technique and practice regarding how to strike the key (attack) and make it sustaining (steady-state and decay), as well as pursuing the appropriate timbral effect in any one particular musical context. The opinions of Turner (1939), Ortman (1925), Parncutt and Troup (2002) who hold that musicians pay less attention to the scientific side of performance, might need to be reconsidered.

The reasons that pianists have a different perspective and understanding of piano timbre is obvious – the overemphasis on the tone quality of isolated piano tones is not the major concern for

pianists who are concerned with tone production in a polyphonic and melodic context. They seldom play music with one singular tone; they don't necessarily face the challenge of how to vary timbre while keeping the same intensity and duration. Their actual challenge is managing the mixture and interplay of various performance parameters (e.g. timing, dynamics, timbre, and articulation), and to consider timbre production in a musical context where music communication and expression is at the centre of performance. They believe that there are mental and imaginary components involved in the process of tone production, and that physical examination alone would fail to discover the truth if timbral nuance was only to be regarded as a sonic outcome. Additionally, what pianists are concerned with is the impact on tone resulting from different interpretations, understandings, and playing techniques, as a result of which, changes of concurrent intensity as well as temporal features all belong to the category of changing of tone.

Researchers need to find an approach that focuses on the conceptualisation of piano timbre of musicians. Why do pianists prefer to say that they have changed the *timbre* rather than the *intensity* in performance? Why do listeners regard timbre as the primary impression of a piano performance and intensity as a subcategory of the timbral effect? Why do students and teachers repeatedly work on different touch types in piano lessons and experiment with them focusing on one piano tone or chord, even though this would seem to be pointless from the acousticians' viewpoint? It seems that the value, meaning, conceptualisation, and significance of timbre in a musical context is different from the areas that acousticians normally focus on, and this has left a rich space for my research to explore. The following section will illustrate the extent to which pianists conceptualise the notion of piano timbre in various ways.

2.2 The Concept of Piano Timbre in Performance Context.

Timbre plays a significant role in the context of musical performance since musicians employ a range of tone qualities to make an expressive performance. The following are reviews of studies in which researchers implicitly or explicitly mentioned 'timbre', 'tone quality', and 'tone colour'.

Kochevitsky (1967) suggested that the quality of piano tone depends mainly on a pianist's mental conception. It is this inner concept of the desired tone quality that guides and motivates pianists to move their arms, hands, and fingers. Thus, the idea that observing the playing hands of a great pianist will unlock the secret of producing a good tone quality, is misguided; and according to Kochevistsky, to listen is more important than to look.

Berman (2002) described piano timbre by referring to the concept of 'sound': He argued that sound production was largely neglected by piano teachers and their pupils. Compared with playing techniques which emphasized the ability of playing rapidly and evenly, sound production needs to be considered in a broader sense. The notion of 'proper sounds' relates to a stylistic awareness with which a performer interprets a musical piece with an appropriate choice of tempo, rhythm, phrasing, and articulation. Therefore, pianists should have both a 'subjective ear' and an 'objective ear'. The former guides pianists to create an 'image of the kind of sound he would like to produce', while the latter requires pianists to 'monitor the sound that actually comes from under his fingers' (p. 13).

Hamilton (2012) associated the tone colour of the piano with 'the illusion of different hues by dynamic contrasts and shadings', thus his concept of piano timbre is strongly associated with changing dynamics. He argues that there is a limited range of tone quality available on the piano itself, and that the most effective way to vary the tone colour is to apply different degrees of force. A sharp tone is produced by striking violently, combining with brighter upper partials and greater vibrations of the string; while soft sounds can be produced by pressing the key gently, resulting in reduced remote upper partials and differing in tone qualities. However, Hamilton's (2012) concept of how tone colour and dynamics link with each other can be seen as limiting: dynamics can be varied with different forces applied to the keyboard, but tone colour can be changed not only with the degree of force but also various other types of touch such as reducing the finger-stroke noise, variety of articulation, and the use of pedal.

Bernays and Traube (2014) applied this notion of timbre in a polyphonic and expressive piano performance context, where pianists use elements of articulation, touch qualities, and pedalling to pursue a subtle tone combination, while keeping the rhythmic and melodic structure unchanged. Hence, the concept of 'composite timbres' is created, referring to the noticeable nuances in piano tone which make an expressive performance.

In summary, we can see from this review that the conceptualisation of piano timbre differs significantly from one pianist to another when considering an expressive piano performance. Pianists relate timbre concepts to various aspects including the mental process (Kochevitsky, 1967), stylistic interpretation (Berman, 2002), dependence on musical dynamics (Hamilton, 2012), and expressive performance parameters (Bernays & Traube, 2014). The perception of timbre in a musical performance might interact with the musical structure, other performance parameters, or subjective interpretations etc. In this sense, the definition of piano timbre seems to extend to a general concept of performed 'sounds' and is associated with other musical attributes which are not typically considered in the definition of timbre. However, this is in line with several previous studies (e.g. Holmes, 2011; Bernays, 2013) which considered other performance aspects (e.g. emotions, metaphors, performance attributes) to be integral to timbre and included them in the data analysis. Due to the adoption of a phenomenological approach in this thesis, it is hard to separate the subjective experience of timbre from other musical attributes and factors; everything seems intertwined and the perception of piano timbre is multi-faceted: the notion of timbre is not merely a sonic feature of piano tones, but is used as a holistic and temporally extended phenomenon.

This section highlights the importance of the study of piano timbre in a musical context rather than from a purely psychoacoustic perspective that regards timbre as a physical property of sound. The following section reviews recent studies of the perception and production of piano timbre, including psychoacoustic studies, examinations of playing techniques, precise measurements of keyboard mechanics, and psycho-linguistic studies on timbre descriptors.

2.3 Existing Work on Piano Timbre

2.3.1 Psychoacoustic studies

Conflicting results of touch-tone relationship have been discovered by a few acousticians with more careful examination and experimental manipulation. Goebl, Bresin, and Galembo (2005) examined the effect of pressing and striking touches on piano tone and whether pianists are able to discriminate sounds of equal dynamic level produced by two types of touch. The spectral analysis showed that there was a difference made by two types of touch, with a bigger 'attack noise' from striking the key, before the onset of the tone. The results showed that pianists used the finger-key noise as a cue to discriminate sounds in the task when the attack noise remained in the sound recordings; however, they failed to make accurate judgements when the attack noise was removed from the sound recordings by experimental manipulation and tended to assume that a striking touch was louder than a pressed touch. This is consistent with Schaeffer's (1966) studies on the influence of attack noise on the identification of timbre, indicating that the timbre of a bell became like the sound of an oboe when the attack noise was removed from the sound recording.

A study has also been conducted to examine the impact of key-bottom noise (Goebl, Bresin, & Fujinaga, 2014). It found that musicians were able to distinguish whether a tone contained key-bottom noise, when other attributes such as hammer velocity, pitch and duration were constant. Suzuki (2007) examined the effect of tense/relaxed finger strokes on spectral changes of piano tone, and found that only the spectral information of the final tone of three tones was influenced. However, this effect was not apparent without carefully comparing the results of spectral analysis; not all the participants could discriminate the difference when confronted with the tones in a later listening study.

The literature considered above suggests slightly controversial results in research into the touch-timbre relationship: that piano timbre can be changed independently of other musical features; that several aspects of touch qualities, especially the attack noise (onset noise and key-

bottom noise), are under the control of pianists. What is more exciting about these studies, however, are the results of the perceptual listening experiments: pianists can recognize and differentiate between sounds that have equivalent intensity via the cue of sound-producing actions in terms of whether it is struck, whether it reaches the bottom, and whether it is relaxed. The association between sound outcome and sound-producing gesture appears to be recognized by pianists when interpreting piano timbre.

However, the limitations of the psychoacoustic approach are also significant: a) the lack of understanding of the performer's perspective; and as mentioned b) using singular piano tones rather than an actual musical context. Apart from focusing on the examination of produced sound, scholars have also investigated the motional features of the piano keyboard in the production of particular timbral qualities.

2.3.2 Key motion measurements

The physical movement of piano keys has also been measured to study its correlation with particular timbral intentions. This provides a precise examination of instrumental movement when pianists employ a particular touch quality or pursue a desired timbre. Measurements of keyboard movement are carried out by a device attached to the instrument, for instance a key-position sensor (McPherson & Kim, 2013) and the CUES system embedded in a grand piano to capture key/hammer/pedal movements (Bernays & Traube, 2014). In the study of McPherson and Kim (2011), participants without professional musical training backgrounds were required to play music on a Steinway L grand piano equipped with a sensor device, in order to capture the multi-dimensions of keyboard movement including velocity, percussiveness, rigidity, weight, and depth. They were trained to play a brief piece of music with distinct expressive intentions (e.g. ‘playing like flowing water’; ‘…as if the keys are extremely hot to touch’; ‘…as if there are no bones in your hand’). The results showed that untrained performers were capable of varying all the keyboard action parameters to express the given instructions, not just the velocity of keypresses;

they were able to control certain parameters when they were discretized into smaller classes (e.g. low/medium/high velocity; light/heavy weight). Bernays and Traube (2014) also examined the key motion (key-depression depth, duration, speeds, release etc.) in the performances of five advanced pianists. With the aid of key motion information, this study found that the pianists used personal performance strategies to highlight the features of different timbres (e.g. bright, dark, etc.): for example, pianist A had characteristically the lowest dynamics but the more legato attacks; whilst pianist C favoured the highest and most steady intensity but the fastest attacks.

The benefit of analysing instrumental gestures is to quantify and generalize the physical patterns of keyboard movements in relation to the expression of a timbral intention. This approach can work as an objective measurement of the production of piano timbre. However, this study is not interested in the examination of instrumental gesture; but rather focuses on performers' gestures, i.e. the embodiment of a timbral intention. The reason will be explained in more detail in section 2.4. However, future research projects could consider analysing the correlation and consistency between instrument 'gesture features' and performers' gesture features, for instance, to examine whether expressive gestures (e.g. floating elbows, inward movements) influence the key-motion parameters (e.g. key-depression depth, hammer velocity) as compared to a deadpan gesture.

2.3.3 Verbal descriptive studies of piano timbre

Another approach to investigating the perception of piano timbre is to examine the verbalization of timbre descriptors. To begin with, researchers have suggested that humans have some communication difficulty with respect to timbre impressions (Fales, 2002; Wallmark & Kendall, 2018). For example, musicians can easily describe the music itself by referring to the tonality, the form, the structure, or harmonic changes; however, there are difficulties in finding vocabulary to describe timbral features. We tend to use adjectives (e.g. warm, nasal, pleasant) from multiple domains to express our feelings of sounds, as can be seen from the studies reviewed below – in

which context, the impression of piano timbre is associated with emotional valence, kinaesthetic experiences, and aesthetics.

Bellemere and Traube (2005) conducted a study on the free verbalization of piano timbre descriptors. They asked pianists to identify ten adjectives that were most appropriate to describe piano timbre and explain them using synonyms/antonyms as well as the physical production process, which finally generated over 100 descriptors. This study found several high-frequency, key adjectives (e.g. bright, clear, distant, harsh, round, shimmering, and warm). Later, Bernays and Traube (2011) quantified the semantic structure of timbre descriptors and identified the most encompassing subsets of descriptors, based on Bellemare & Traube's study (2005). This study created five subsets of timbre descriptors based on cluster analysis of familiarity and similarity ratings given by pianists in response to a questionnaire, namely: bright, dark, dry, round, and velvety.

Kojucharov and Rodà (2015) collected adjectival descriptors used by pianists to define touch and timbre from a questionnaire, and categorized their responses into five domains: physical motor (by fingers/arms), articulatory (legato/staccato), sensory (heavy/light/soft), emotional (relaxed/tender/powerful), and aesthetic-stylistic (Baroque/beautiful/modern). This study found that touch descriptors were equally distributed across the five categories while timbre descriptors exclusively fell into the sensory, emotional, and aesthetic/stylistic categories.

The benefit of a linguistic approach to the study of piano timbre is its possible relevance to and application in musical contexts, and its access to the inner interpretative world of piano timbre experienced by pianists. However, an understanding of what contributes to this 'colourful' verbalisation of piano timbre in pianists still remains unclear.

2.4 Research Gaps

Thus far, the literature reviewed above provides distinct insights into the study of piano timbre: either by the examination of the subjective response of listeners to the perception of piano timbre

(as shown in the linguistic studies); or through the demonstration of physical production of timbral nuances and perceptual sensitivity of these nuances (as in the examinations of touch qualities and keyboard movement measurements). These studies have generated valuable data relating to the investigation of how various piano timbres are physically produced and showed the richness of ideas in pianists' minds with regard to the concept of timbre. This has implications in the context of musical pedagogy and the development of creative musical technology.

However, approaches focusing on conceptualisation and psychoacoustic principles explain only half of the mind-body circle: from concept to production, or from produced sounds to perception. They do not go full circle (see Figure 2.1). The main weakness is that these studies have adopted a disembodied perspective of studying piano timbre, failing to address the connection between the mental process of timbre conceptualisation and the physical production of colourful sounds. More specifically, it is still unclear exactly what the relationship is between physical human actions on the piano and the subjective experience of produced sounds, and what contributes to the richness of pianists' concepts of piano timbre. In other words, the question of the relationship between the body, the sound, and the mind in piano playing still needs to be clarified. An embodied approach to studying timbre examines the coupling between perception and action, and some authors have recently argued this point and started to explore this.

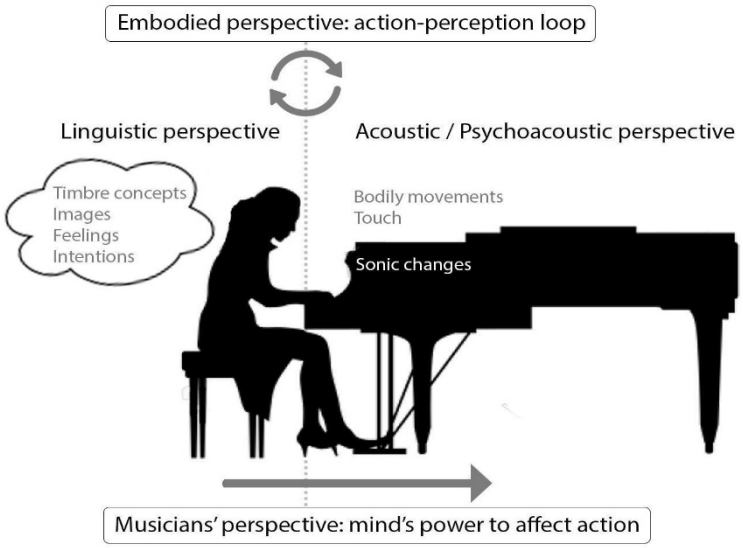


Figure 2.1. Embodied perspective to study piano timbre.

The embodied approach is the main hypothesis in this research into the perception and production of piano timbre. As a pioneer of studying piano timbre from an embodied perspective, Parncutt (2013) questioned the disembodied perspective of piano timbre and suggested several new insights into the investigation of piano timbre. He argued for the role of weak cross-modal synaesthesia in the perception of piano timbre, and claimed that this is the reason why pianists believe various touches can affect piano timbre, disagreeing with acousticians' findings of limited influence. Parncutt and Troup (2002) also claimed that the other concurrent musical attributes affect the perception of piano timbre; pianists almost never play isolated piano tones without using the pedal, while listeners cannot simply separate timbre from other musical attributes such as pitch and loudness when listening to musical sounds. In addition, the perception of timbre by performers can be influenced by kinaesthetic feedback from the finger contact with the keys; while for the listeners, their perception of timbre may be influenced by visual perception of a music performance (e.g. perceiving a hard/brittle tone after watching a pianist brutally hitting the piano, Parncutt & Troup, 2002, p. 290).

Parncutt (2013) questioned the acousticians' approach to the study of a singular piano tone with no musical context, and this has informed my study of piano timbre, that it should be from both the performer's and listener's perspective – for whom the sounds may be perceived differently by distinct sensory modalities. However, although Parncutt's study focuses on the contribution of cross-modal sensory modalities to timbre perception, it fails to explain the fact that pianists integrate both mind and body in their perception and production of timbral concepts. The coupling of intentions, gestures, sound-producing actions, and the sonic outcomes is the missing piece in Parncutt's embodied account of timbre perception.

To conclude, my research will be rooted in an embodied perspective of piano timbre with an understanding that pianists may perceive piano timbre from multisensory modalities - not only

auditory perceptions, but also tactile perceptions such as from the touch on the piano. These perceptions are embodied in physical actions relating to the production of timbre. The coupling of sound and action is assumed to be of similar interest in listeners, and teachers and students. Chapter 3 will explain the rationale and mechanism of an embodied account of piano timbre in more detail.

2.5 Definitions of Timbre

This thesis studies piano timbre from a micro-perspective. In general, timbre studies have usually adopted a macro-perspective, which considers the differences in timbre produced from various sound objects. The 'macro-perspective' focusses on the characterisation of timbre of specific instruments or instrument groups. This could also concern differences within an instrument group (i.e. the timbre of piano A is different from that of piano B). This perspective tends to ignore the variation of sounds produced on a given instrument. An important aim may be to uncover the timbre space through which listeners categorise or distinguish instrument timbres (e.g. timbre intervals, McAdams & Cunibile, 1992). The micro-perspective focuses on the timbral nuances produced from one instrument, from the point of view that a specific instrument can still have a variety of timbres depending on how the instrument is played (e.g. piano A has contrasting timbres when the key is either gently pressed or quickly struck).

These different approaches to timbre also have consequences for how timbre is defined: Two types of definitions of timbre exist which emphasise either sound source or sound quality. The underlying reason is due to the fact that there is still no single, generally accepted definition of timbre – and this fact has raised several challenges in the area of research into experimental manipulation of timbre (Hajda, Kendall, Carterette, & Harshberger, 1997). Additionally, synonyms relating to timbre include 'tone colour', 'tone quality', and 'the tone'. Both acousticians and musicians have acknowledged these differences but they have failed to make a clearer explanation on the utilisation of terminologies. This section aims to show how the present study aligns with a holistic picture of timbre research.

2.5.1 Identification of sound source.

The first type of definition of timbre is on the basis of sound source discrimination, and considers timbre in the context of being produced on different instruments. The standard definition of timbre from a psychoacoustic perspective has been given by ANSI (American National Standards Institute), which states that: 'Timbre is that attribute of auditory sensation in terms of which a subject can judge that two sounds similarly presented and have the same loudness and pitch are dissimilar' (ANSI, 1973, p. 56). McAdams, Depadalle, and Clarke (2004) added a condition to this definition: that the sounds have to be presented under similar conditions with the consideration of the effect of surrounding physical environment. However, this definition is still limited by only clarifying what timbre is *not* (it is not pitch, loudness, and duration), and it fails to explain the reason why listeners are still able to tell that timbres from different instruments are dissimilar regardless of presented pitches and volumes. Later, Pratt and Doak (1976) complemented this definition of timbre by defining it as 'that attribute of auditory sensation whereby a listener can judge that two sounds are dissimilar using any criteria other than pitch, loudness or duration' (p. 317).

When defining timbre by the criteria of discriminating two different sounds, a parallel has been made between the notion of timbre and the notion of looking (Patel, 2008). As Patel (2008) argued, imagine there are four qualities (width, length, complexity, and 'looks') to describe the face, and people tend to use looks to describe their opinions intuitively and spontaneously when two faces are matched in width, length, and complexity. This is very similar to the situation of using timbre to discriminate two sounds when other sound attributes (pitch, intensity, and duration) are the same. Patel (2008) further explained that looks do not represent a unitary physical dimension, but is 'a label for an overall quality created by the interplay of a number of different features' (p.29). This parallel implies that timbre perception relates to the global impression of multiple sound features. Similarly, Fales (2012) argued that timbre contributes to a larger sensation

of musical sound: timbre is perceived in the auditory cortex where all signals (pitch, intensity) are reached, grouped, and subjected to 'the process of perceptual fusion into the unitary sensation of tone quality' (p. 62) These statements acknowledge one of the functions of timbre as an effective tool to distinguish or discriminate between sound sources, but they also indicate the superiority of timbre in auditory experience above other acoustic attributes. In other words, a listener might perceive several classes of information that are specified in a musical sound (pitch, loudness, duration, and timbre), but he/she tends to pick *timbre* as the main, identifiable feature of the sound. McAdams (2013) claimed that when listening to orchestral sounds, timbre plays a primary role in the grouping and segmenting of musical materials rather than pitch and duration; and that a different orchestration of a given pitch can completely change our impression of melody and rhythm (Wessel, 1979). This highlights the interacting forces between timbre and other musical properties.

Describing the differences in timbre or tone quality of various instruments is not easy. We tend to do this by using metaphors or by drawing an analogy with other senses. For example, it is quite common for a listener to describe a perceived timbre as a 'plucking sound' or a 'bowing sound'. In this sense, the identification of the sound source is associated with particular physical actions. The definition of timbre given by Handel (1995) followed this idea, and defined timbre as 'the perceptual qualities of objects and events; that is, 'what it sounds like' (p. 426). For example, we can distinguish a guitar timbre or violin-timbre because it is easy to recognize the unique physical actions used to generate that instrumental timbre. Handel (1995) suggested two possible explanations for this: that timbre might be perceived as physical movement (e.g. plucking or bowing) that produces particular sounds; or that timbre might be perceived as a sum of acoustic properties but that the *learning schema* creates a connection between the acoustic information and the sound object. No matter which explanation, this statement acknowledges that the identification

of a sound source results from an understanding of acoustical information and the physical production process.

The origin of Handel's definition comes from an ecological perspective on the human listening experience (McAdams, 1993). Gibson (1966) suggested that an ecological way of listening makes sound sources to be perceived as meaningful events through the perceptual attributes of sounds or events in the world. This has its significance in the everyday listening context (Lemaitre, Susini, Winsberg, McAdams, & Letinturier, 2007). Handel's definition of timbre also has relevance to the present study, since it recognizes the aspect of gestural control (i.e. the performer's actions) on the production of piano timbre, and acknowledges the fact that the verbalization of piano timbre is closely associated with that of physical movement (e.g. a struck tone; a pressed tone).

2.5.2 Tone-quality dimension

The above descriptions describe the function of timbre perception as that of discriminating between sounds and identifying a sound source. Perception of timbre can also be related to a quality-dimension. Rather than regarding the timbre of an instrument as a unity, Schaeffer (1966) suggested that every sound object produced from an instrument has its own particular timbre. Schaeffer further noted that when musicians talk about timbre, they use phrases such as 'a rich tone' or a 'good timbre'; the concept of timbre in such circumstance refers to: 'every object produced by the instrument', which is 'an appreciation of the musical effects contained in the objects themselves, effects that are desired by both musical listening and musicianly activity' (p. 180). This statement is different from other definitions of timbre in its use of discrimination or source-identification functions. By recognizing timbre as a characteristic belonging to every sound object, this definition acknowledges the possible timbral nuances produced within a particular instrument. Put into the piano performance context, it is therefore reasonable to suggest that every

tone produced on the piano has its own individual timbral characteristics which are in accordance with everyday verbal discourse about timbral experience when hearing a piano performance.

Marozeau (2004) defined timbre as 'the *perceptual assessment* of a sound, regardless of its pitch, duration, intensity, or localisation – like the sound of one piano note.' (cited in Bernays, 2013, p. 10). Bernays (2013) stated that the quality-perspective view explains the performer's reason and motivation behind changes of timbre in a musical performance, and also explains the phenomenon that numerous adjectival descriptors are used to describe these sounds, such as sour, dry, rich, mellow etc. He claims that the quality-dimension concerns the sound object and its surface attributes rather than defining the sound source (ibid). Ortmann (1935) studied tone quality in a piano performance and its close relationship with other musical attributes. He suggested that the perception of tone quality is subjective, and that it is a result of our unified reaction to the three variants of pitch, intensity, and duration; any variations in these three physical elements in the original stimulus may affect the tone quality.

2.5.3 Timbral blend

Sounds that have similar timbres are likely to have similar sources. McAdams and his colleagues applied this knowledge to explain the function of timbre in the context of orchestral sounds, and suggests that timbre should include the idea of *timbral blend* in the perception of polyphonic voices or orchestral performance (McAdams, 1993; Goodchild & McAdams, 2018). More specifically, timbre influences the way that listeners integrate or segment the musical materials, since similar timbres that represent similar sources are more likely to be grouped and blended (McAdams, 2013). Rather than defining what timbre is, McAdams, Depadalle, and Clarke (2004) addressed the puzzle of when the listeners might fail to identify the voice of each singular instrument but still perceive a blended timbral effect. They explained that this phenomenon is a result of perceptual fusion when concurrent acoustic components are grouped into a single auditory event, and that such a perceptual unit has a beginning and end. The blending effect depends on a number of factors: onset

synchrony of the constituent sounds and acoustic cues such as similarity of attack and differences in the spectral centroids etc.

2.5.4 Terminology differences: timbre, tone quality, and tone colour

Timbre is sometimes described using synonyms, such as 'quality of tone', 'tone quality', 'tone colour', and the universal but vague 'sound'. Wallmark and Kendall (2018) offered a historical review of the utilisation of timbre terminologies by checking the Google English corpus from 1800 to 2008 (over 200 billion words). They found that none of these words or phrases (timbre, tone quality, quality of tone, tone colour) were used before the first half of the nineteenth century; the peak usage of the term 'timbre' in English was between the 1970s and 1980s, due to the development of psychoacoustics and signal processing at that time. In contrast, the terms 'tone colour' and 'tone quality' were utilised in English from 1980s as a consequence of the translation, by Ellis, of Helmholtz's book *On the Sensations of Tone as a Physiological Basis for the Theory of Music* (ibid, 2018). This study indicates that the prevalence of certain terminology has been a result of certain research areas/subjects, and the dissemination of core research. The present-day trend is that the term 'timbre' is widely used and has been incorporated in research, along with clusters of its synonyms. For example, the recent publication *the Oxford Handbook on Timbre* (2018), and two conferences *Berlin Interdisciplinary work on Timbre 2017* and *Timbre is a Many-Splendored Thing 2018* are evidence of this trend and have attracted timbre studies from fields such as philosophy, musicology, ethnomusicology, music psychology as well as acoustics and computer science.

The differences in the definition between 'timbre', 'tone quality', and 'tone colour' have only been explained by few researchers (e.g. Łętowski, 2014). In most cases, acousticians and musicians use a mixture of these terminologies without clarifying the difference. For example, Wessel (1979) defined 'timbre' as the colour or quality of sound, and Fales (2002) claimed that timbre results from a 'perceptual fusion into the unitary sensation of tone quality.' (p. 62). Pianists

use various terminologies in their own individual ways. Kochevitsky (1967) frequently referred to 'tone quality' as associated with an evaluative dimension such as 'a desired tone quality'. Hamilton (2012) generally used the term 'tone colour' and linked it with the production of various dynamic hues. In contrast, Łętowski (2014) differentiated between the notions of 'timbre' and 'tone quality' with regard to the emotional aspect of sound perception. He argued that 'sound quality' is a term that relates to preference and satisfaction scales, relating to whether or not a listener can express their satisfaction or dissatisfaction with a sound event; while 'timbre' relates to similarity scales. Therefore, for Łętowski, 'tone colour' is a subspace of 'timbre' rather than its synonym (ibid).

This research project, while acknowledging these subtle differences in definition and terminology, will generally use 'timbre', 'tone quality', and 'tone colour' as interchangeable terms throughout the thesis. However, it is important to note that 'timbre' is used as a general, technical term and will be used throughout the thesis, while 'tone quality' tends to be used more frequently by musicians during the interviews, specifically when expressing satisfaction or evaluation of a piano performance. The term 'tone colour' is mentioned less often in this thesis and sometimes is rephrased as 'colourful tones/sounds'. It is worth mentioning that 'tone colour' is not necessarily relevant to specific colours as a synaesthete would use the term (e.g. to evoke an orange colour by using a certain timbre); instead, 'tone colour' could simply be used as a non-technical reference to piano timbre.

2.5.5 Intermediate summary

To conclude this section, three categories of timbre definition were reviewed, namely: source discrimination, quality assessment, and global timbre. These offer some guidelines to the study of piano timbre. I will argue that each of the three criteria are valid and are implied in research of piano timbre at various times. Firstly, the criterion of source identification seems to be more applicable in the context of a macro-perspective view of timbre, to explain why humans can easily distinguish between timbres of different instruments (i.e. different *sources*); however, it also works

well in the context of a micro-perspective view, in terms of why pianists can discriminate between a struck tone and a pressed tone (i.e. different *action causes*). This aspect has its significance in explaining the performer-controlled aspect of piano timbre. To identify a source a listener perceives not only acoustic information that is specified by the source, but also the action possibilities that generate the sound (Clarke, 2005). When timbral nuances played by a pianist are presented to a listener, they will perceive the physical-action information specified by the sound object. The ecological explanation helps to understand this sound-action relationship in piano timbre perception.

Secondly, a quality-dimension is more applicable to the study of piano timbre when considering that each sound produced from a piano is a sonic object that varies in timbral qualities. It is a dimension that listeners use to judge, evaluate, and assess their perceptions, and therefore may be subjective and associated with aesthetic factors such as satisfaction, happiness, preference etc.

Thirdly, the idea of blended timbre has its significance in the context of piano performance, since piano timbre is barely perceived in situations of isolated tones but is more evident in a polyphonic context. For example, pianists can either asynchronize the notes of a chord or change the dynamic balance between left and right hand to create distinct timbral effects. The notion of timbral blend helps to understand the temporal feature in the perception of piano timbre, in which context the continuous changes in piano timbre have an impact on listeners' auditory experience. When there is a variety of piano timbre in a musical performance, listeners' auditory experience are shaped by timbral effects, for instance, some materials are grouped while others are separated.

2.6 Summary

This chapter started with an examination of touch-tone relationships from the viewpoints of both acousticians and musicians. As opposed to previous studies of piano timbre which tend to conclude with a conflict between the scientific and artistic perspective, this study offers more insight from

the viewpoint of musicians, and, indeed, suggests the fact that musicians do not ignore the scientific aspect of tone production. The literature review also points to the fact that less attention has been paid to performers, and that there is a lack of suitable approaches to the study of the integration of sound, action, and the mind. In addition, the various definitions of timbre have been reviewed and summarised to three criteria, namely: source discrimination, quality assessment, and global timbre. Their implications for the study of piano timbre are the indication of a sound-action relationship in sound perception, and the subjective and global impression of piano performance.

The following chapter will illustrate the main concepts of embodied music cognition and its application in piano timbre studies. The perspective of piano timbre from a pianist's point of view (i.e. first-person perspective) will be explored with the aid of embodied cognition theory, regarding how pianists themselves conceptualise piano sounds and what the role of bodily movements is in the conceptualisation process. A number of empirical studies that have taken an embodied perspective on timbre studies will also be reviewed, in order to draw a link with piano timbre studies.

Chapter 3: Embodied Perspective on Piano timbre

'*Inside the piano, the elaborate arrangement of joints and springs will only cause the hammer to hit the strings with greater or lesser force. The graceful or dramatic movements of the arms and wrists of the performer are simply a form of choreography that has no practical effect on the mechanism of the instrument, although if it looks more graceful, it may sound more exquisite, not only to the public but to the pianist convinced by his own gestures*.'

-- Rosen (2002, p. 24)

3.1 Introduction

The second chapter of this thesis has shown that piano timbre has been extensively studied from an acoustic perspective. The quality-aspect of piano sounds is tacit knowledge in music practice, and much attention has been paid to practical aspects (i.e. how to achieve and improve timbral qualities), more so than to conceptual aspects (i.e. mental activities and the conceptualisation process). However, the conceptualisation process in the production of piano timbre has raised several interesting questions for researchers to answer, such as: Why have pianists developed hundreds of descriptors and metaphors to describe perceived timbral features in piano performance? What contributes to the conception of piano timbre? This chapter will reveal the relevance and central role of the body in the mental construction of piano timbre concepts.

The previous chapter also highlighted the limitation of disembodied perspectives when studying piano timbre. For example, the linguistic approach that examined performers' and listeners' experience of piano timbre has not explored any connection between bodily movements and the mental representation of sounds – as if the internal representation of musical sound is separated from the external physical world and subjective experiences including the body. This calls for an investigation of the role of the mind/body relationship in the perception of and production of piano timbre from an embodied perspective. The debate about mind-body separation

versus integration has attracted interest from the fields of philosophy and cognitive science, however, less is known about how mind-body connectivity is reflected in musical practice and in the conceptions of musicians. This literature review considers the mind-body issue from both sides and addresses the question of what an embodied approach offers to the study of piano timbre, and considers the differences between an embodied and disembodied perspective of piano timbre.

The literature review will start with an explanation of embodied cognition theory, and will make suggestions of the implications for music performance studies. This will be followed by a consideration of embodied cognition perspectives on language (Section 3.3). The first reason for this is that the employment of a (dis)embodied approach to the study of linguistic cognition has been hotly discussed (Kaschak, Jones, Carranza, & Fox, 2014); meanwhile music research has been influenced by several landmark researchers' ideas regarding embodied metaphors and image schemas (Lakoff & Johnson, 1980; Johnson, 1987). Key notions such as cross-modal mapping and blended concepts have started to be used to explain music conceptualisation (Zbikowski, 2002) and the association between music and motion (Eitan & Granot, 2006). The second reason is due to the extensive utilisation of language in the description of piano timbre, including the semantic space we use to describe perceived timbral qualities (e.g. words, adjectives, action-oriented sentences), as well as the cognitive space that we use to construct our thoughts regarding piano timbre (e.g. metaphors, concepts). Section 3.3 will explain the process through which language utilisation/understanding and conceptual structure (i.e. metaphors, concepts) are shaped by movement activities.

Apart from language, another crucial aspect of an embodied approach to music studies is to consider what and how bodily movements shape musicians' minds. Section 3.4 will explain what types of movement are relevant to piano timbre studies. To understand the mechanism and rationale of an embodied approach to the study of piano timbre, basic notions will be explained such as motor-sensory association, mirror neurons, action-based effects, cross-modal association

etc. Taken as a whole, this chapter will enrich understanding of timbre-related language, movements, and minds, and the interplay between these elements as they correspond to a so-called embodied approach to piano timbre.

3.2 Embodied Cognition Theory

3.2.1 Background: Mind-body separation or integration?

Before the prevalence of embodied cognition theory, mind-body dualism was dominant in the fields of philosophy, psychology, and linguistic research, which has been strongly influenced by Cartesian philosophy. The most typical statements of early cognitivism claimed that the human brain is like a computer which manipulates information for 'problem-solving' tasks; that knowledge is constituted through a symbolic process and has no relevance to bodily movement. For example, Fodor's theory (Fodor, 1975, as reviewed by Gallese and Lakoff (2005) claimed that knowledge is represented as symbols in our mind, and that the obtaining of meaning is a referential process in which correspondences are established between the system of abstract symbols and the corresponding extensions, objects, and events, in the physical world. As an example, Lakoff (2012) used a 'Chomskyan metaphor' to explain how people understand language as abstract symbols without the role of body and brain:

> A sentence is a string of meaningless abstract symbols; a language is a set of such strings; and a grammar is an algorithmic method of generating such sets of strings, independent of meaning or communication or any aspect of *embodiment*. (p. 774)

Statements such as this take a disembodied position to the mind-body question, as they ignore the role of the human body and the environment in which it is embedded in the construction of knowledge.

Embodied cognition theory (ECT) has questioned and debated the issue of separating the mind from the body, from the considerations of the relationship between the subject and the environment. One of the main points is that humans perceive external environmental information

through interaction: they construct knowledge in an 'active' and 'enactive' manner instead of passively perceiving it (Varela, Thompson, & Rosch, 1991). By using the term 'embodied', Varela et al., (1991) aim to highlight two aspects:

> First, that cognition depends upon the kinds of experience that come from having a body with various sensorimotor capacities, and second, that these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context. (p. 173)

This thesis will draw on basic aspects of embodied and enactive theories of music cognition, with an emphasis on the former: 'embodiment' is relied on to explain the significance of musical gestures and bodily movements in a piano performance for timbre perception as well as the relevance of the interaction with the instrument and musical surroundings. Furthermore, this thesis acknowledges the relevance of knowledge construction through action and experience. As claimed by Wilson (2002), bodily movements and the physical inputs and outputs assist our thinking and knowing -- "rather than the mind operating to serve the body, we find the body (or its control systems) serving the mind" (p. 635).

To verify the view of embodied cognition, relevant research findings have been found in the observation of animal behaviours. In a classic study conducted by Held and Hein (1963), kittens were raised in two distinct conditions: the first group of kittens were harnessed but allowed to walk around in a dark environment and were exposed to sunlight under certain conditions; however, the other group of kittens, although moving in the same direction, were placed in a carriage and did not physically walk – they were exposed to sunlight in the same conditions as the first group of kittens. The study results revealed that kittens gained motor ability and spatial information by active interaction with the environment: the first group of kittens could move efficiently after a few weeks but not the second group of kittens who acted as if they were still blind (bumping into objects and falling over edges). By physically moving, the first group of

kittens were able to associate implicit knowledge with certain movement features such as direction and pace; on the other hand, the second group of kittens had some motoric skills but fail to associate these with the spatial knowledge. Therefore, action and perception was successfully coupled in the first group but failed in the second group.

The human body also plays an active role in constructing knowledge and experience by interacting with a physical environment. For example, blind people often perceive their stick as an extension of their bodily space as they use it to detect the physical distance, location, and the size of their environment (see a discussion in Hirose, 2002). Musical learning works in a similar way, and this study assumes that some aspects of musical knowledge, for instance sensorimotor skills, and spatial knowledge of a musical instrument, can be gained via musicians' active playing of, and interaction with, their instruments. As claimed by several scholars (O'Modhrain & Gillespie, 2018; Nijs, 2017), the piano can also be regarded as an extension of the performing body. O'Modhrain and Gillespie (2018) claimed that the piano is an instrument that can, not only be driven by the performer, but also can drive the performer; there is a haptic exchange between the performer and the instrument, and a dynamic coupling between the mechanical system of the instrument and the biomechanical instrumentalist. When striking a key, pianists have to actively employ force and energy to the keyboard; they will also receive energy that is pushed back from the instrument because of the springy and inertial mechanical system. Nijs (2017) related the merging of musicians and their instruments to the idea of 'flow experience' in musical performance. He explained that: 'every time a musician experiences flow, the musical instrument becomes transparent and temporally a natural extension of the body.' (p. 51).

Apart from the similarity, I would argue that embodied learning in a musical context is more enjoyable and dynamic than the learning in non-musical context (e.g. everyday activities). The experience and knowledge gained from the physical world seems to be pragmatic and stable to some extent, something that enables humans to adapt to the living environment. For example,

making the decision to move away when hearing a car horn, and adjusting our legs to relevant heights when stepping on a ladder. In a musical context, the embodied interaction with the musical instrument awards the performer both pleasures; performers move their bodies while listening to the sounds that are being generated from the instrument. The fact that their performing actions are aligned with mental ideas such as an imagined atmosphere or an image, allows them to anticipate the sonic outcomes. This coupling between the sound and the action from the perspective of the performer produces great pleasure and enjoyment. This is in line with the reward idea proposed by Leman (2008), that an intrinsically rewarding experience will occur when skills are adapted to higher challenges brought about by musical learning; during which process, skills and challenges are coupled as a result of the relationship between gestural control (i.e. action) and sound generation (i.e. perception).

An exploration of the relationship between musicians and their instruments is one of the aims in my research – to look at how pianists regard and perceive their instrument. What do they gain from the physical process of producing sounds? Valuable data may be generated to this end via the interview process and perceptual listening experiments.

3.2.2 Mind-body dualism in music research and practice

Differing perspectives on the performer's bodily movements tend to be one of the main differences between an embodied and traditional approach to the study of music cognition. Traditional cognitive theory regards that the human body as being controlled rather than integrated: that subjective involvement with music is mediated by the human brain in the form of information-processing. The perceptual and motor system was modelled as a peripheral 'input and output' device and is seen as playing a marginal role in the understanding of the 'central' cognitive process (Wilson, 2002). A clear example of this is the interpretation of a musical score as primarily consisting of symbolic representations of musical ideas. The role of the composer, therefore, is to

transfer sounds into symbols on a musical score, and the musical performance is then a process of transferring these symbols back into sound (Longuet-Higgins, 1987, as cited in Leman, 2008, p33).

In contrast, an embodied perspective of the perception of musical sounds and notation symbols emphasises the close coupling of sound perceptions with action intentions. For example, Leman and Godøy (2010) criticized the western tradition which overemphasizes score-based sonic events and neglects the role of sound-producing gestures. They hold the opinion that in the perception of musical sounds, the sound specifies the information of both the action that is responsible for producing that sound (e.g. hitting, striking, bowing), and the material properties of the sound source (e.g. string, keyboard, tube).

A disembodied perspective of musical education and practice is common among musicians, for instance advocating composing in the head and having a prejudice against using the piano (e.g. Berlioz, Mozart, cited in Rosen, 2002). Musicians seem to assume that the musical mind is a higher, more advanced organ than the body, and able to carry interpretations, conceptions, beliefs, emotions, and imaginations independently of the physical body; that finger and body movements are a matter of technique and not comparable to the spiritual content of the mind. As Charles Rosen (2002) wrote:

> The finer composer, it is felt, should be capable of elaborating the work of music solely in his head, and ought not to need the crutch of trying it out at the keyboard. This is an interesting example of the snobbish idealism that wishes to separate body and mind, and considers the body morally inferior to the less material, more ethereal, mind. (p. 12)

US pianist and composer Ruth Friedberg (1993) made a statement on the mind-body connection by highlighting the impact of bodily conditions on mental states. She argued that, in contrast to the majority of people, who are convinced of the mind's power to affect the body, she would rather think from an opposite proposition, that a sagging body may sap the energy, inducing depression, while a body with good posture may create positive feelings in the performer. This is

consistent with the ideas of the psychologist, William James, with respect to the role of bodily activities in inducing emotional experience: that people do not cry because of sadness, but are sad because of the tears (1892).

In this research, I will argue that the mind/matter dualism needs to be challenged in the study of piano timbre perception. Firstly, the idea of mind-body separation has drawbacks in musical practice. Musicians take it for granted that the musical mind is a higher, more advanced organ than the body, and its processes such as those of interpretation, conceptions, beliefs, emotions, and imagination can work independently of the physical body; that technique is solely concerned with finger and bodily movements and not comparable to the spiritual content that the mind involves (Rosen, 2002). I would argue that pianist should not put the content of the musical mind in a superior position while putting physical activity in second place. As the Chinese ancient philosopher Confucius said, educational thought, or any artistic activity such as performing music, drawing, or crafting is an activity that connects mind and body. Confucius' idea in terms of mind-body unity and cultivating virtue with music is mainly written in *Yueji*[2] (Wang, 2012), which suggested that the development of the body is self-cultivation, and that to develop the mind is to cultivate morality; that self-cultivation must be based on the cultivation of morality, and that the cultivation of morality must take place in the body and externalized as self-cultivation (Tan, 2016; Zhao, 2007). Secondly, the idea of mind-body integration is consistent with current developments of thinking in music performance research. There are an increasing number of scholars (e.g. Eric Clarke, Marc Leman, Rolf Inge Godøy, Caroline Palmer, Nikki Moran, Katie Overy, Anthony Gritten, Lilian Simones, Andrea Schiavio etc.), who argue for the irreversible connection between the body and musical meaning and experience in music performance and education contexts. Through studying body movements and musical gestures, researchers have gained a richer understanding of musicians' conceptual thought processes as well as insight into aspects of

[2] The earliest document on music in ancient Chinese musical thinking (prior to second and first centuries B.C.).

physiology and kinematics. The significance of the role of the body in the construction of knowledge is likely to be particularly important for musicians due to the centrality of performance in their thinking.

3.2.3 Embodied perspective on timbre perception

Inspired by ECT, the key to gain insight into the perception and cognition of musical sounds is to find its relevance to bodily movements, in terms of the way sound and movement are correlated and influenced by each other when we are making or listening to music. Only a few researchers have examined the perception of timbre from an embodied perspective, either empirically (Traube, 2004), or theoretically (Parncutt, 2013; Doğantan-Dack, 2011). One of the pioneering attempts was made by Caroline Traube and her colleagues, who found a close association between a set of verbal descriptors of guitar timbre and phonetic gestures (e.g. open, oval, round, and hollow etc.) and verified this assumption using acoustic correlates and similarities. In particular, Traube and Depalle's study results (2004) revealed a consistency of formant regions between guitar tones and a particular set of vowels (/æ/, /Λ/, /O/, /o/, /u/). More specifically, the plucking position on the guitar significantly influences the acoustic quality of guitar sounds, which in turn affects how guitarists describe the perceived timbres: the closer the finger-plucking position to the bridge, the richer in high-frequency components, resulting in a brighter and more nasal-like sound (e.g. the word *tea*), congruent with guitarists' descriptions. A rounder guitar sound is played near the fingerboard and may be perceived as a 'round-shaped-mouth' sound (e.g. the word *lock*). Their studies have confirmed that the metaphorical and abstract description of guitar timbre can be related to the physical aspects of speech production. This enriches our understanding of the bodily relevance of sound perception in the sense that speech-related movements help to create a bridge between vowel sounds and musical sounds.

Another embodied approach to timbre perception is to discover to which extent timbre descriptors used by musicians refer to or imply an action by the human body. Observations of

singers is one of the research interests, given that their bodies are their instruments. Prem and Parncutt (2007) investigated timbre descriptors of jazz vocalists, and found a strong link with both technical and physiological correlates. They collected around 250 timbre-related vocabularies in the teaching lessons of six professional jazz singers and interviewed them afterwards to explore the use of timbre descriptors. The results indicated that the word 'free' was taken to mean that the vocal tract is open while 'breathy' assumes that the vocal cords are separated and the sound becomes airy; an 'open' sound might refer to the open vowel sounds used to produce a certain feature and the 'open' impression of the sound itself. Interestingly, this study found that all six teachers described their concepts of vocal timbre in a similar way, showing a considerable degree of shared understanding of timbre descriptors. On the basis of a qualitative interview study, Prem and Parncutt (2008) examined the categorization and evaluation of 250 timbre descriptors quantitatively: one singer was asked to categorize while the other one was asked to rate the corporality of 250 vocal timbre descriptors using a scale from 1 to 7. It was seen that categorization of timbre descriptors is distributed into various domains: apart from describing vocal timbre directly, they also related to subjective pleasant/unpleasant feelings, articulation, technique, and interpretation. This study found that 22 of the 250 words were rated the highest on a scale of corporality, such as: 'anchor', 'articulating', 'attack', 'avoiding', 'constricted', 'relaxed' etc.

Their first study considered the sound-movement relationship from the performer's perspective (first-person): that perceiving timbral qualities in sounds is actually perceiving the sound-producing actions (physically or intentionally). Movements influence sound production and also are integrated into the sound perception, thus influencing how performers describe and understand musical sounds. The second study examined the vocal timbre descriptors from a third-person perspective, regarding the extent to which expert judges understand timbre descriptors as related to sound-producing actions. These studies suggest that the understanding of verbal descriptors requires an understanding of aspects of physical production, and that listeners with

shared performance' expertise have shared knowledge of timbre descriptors. The results also strongly indicated the relevance of timbre descriptors to physiological, physical, and emotional responses in the perception and production of musical performance.

As opposed to guitarists, who integrate their bodies with their instruments by physically holding them, for singers, their body is the instrument; pianists, on the other hand, experience a clear division between the instrument and their bodies. However, a few investigations on the role of gesture in piano performance (e.g. Doğantan-Dack, 2011) have argued for the importance of embodied experience in piano tone production. Specifically, Askenfelt, Galembo, and Cuddy (1998) suggested that a pianist's perception of piano tones is shaped by longer phases of time which begin with finger-key contact; unlike those of a listener, whose experience starts with hammer-string contact. Doğantan-Dack (2011) proposed the idea of initiatory gestures, which form pianists' experience of tones, together with the sound that is produced: 'The performer starts to experience the tone much earlier not only mentally, but also physically, and the beginning of the fixating gesture, before the tone actually starts sounding…' (p. 258). She also noted the importance of initial gestures in shaping the experience of tone quality of a listener, although the listener may not experience the sound in exactly the same way as the performer, who has additional kinaesthetic feedback from the key (2011). However, these assumptions of the importance of embodied experiences in shaping tone perception have not been tested by empirical studies.

To return to the main research question of the interconnectedness of body and mind, the exploratory studies discussed above imply a strong relationship between bodily movement and perception, understanding, feeling, and the description of musical sounds. Musical concepts are undoubtedly integrated into both physical and physiological experience, and are embedded in certain listening or performing contexts. To give a fuller and richer picture of the extent to which the body and the mind are integrated, the following sections will look further into the acquisition

of language and understanding of concepts and metaphors, and will explain their relevance to physicality.

3.3 Embodied Theory of Linguistic Cognition

3.3.1 Language is embodied

Embodied cognitive theory has been confirmed and reinforced in the study of cognitive linguistics. One research domain is language comprehension. A number of researchers have been aware of the fact that language comprehension needs internal sensorimotor simulation (e.g. Stanfield & Zwaam, 2001; Zwaan, Stanfield, & Yaxley, 2002; Glenberg & Kaschak, 2002). Simulations of motions, perceptual attributes (e.g. visual shape, vertical orientation), emotions, and abstractions (e.g. space, time) can arise during the comprehension of words – no matter whether they are nouns, verbs, or adverbs or even entire sentences (see Kashak, Jones, Carranza, & Fox, 2014, for a review). This argument has been confirmed in behavioural studies by observing the change of response speed when a movement specified in a sentence either matches or doesn't match what is required to produce or perceive something in sensibility judgement tasks. For example, Glenberg and Kaschak (2002) asked participants whether a sentence is sensible for them by giving a yes/no response on buttons that move either towards or away from their bodies. The study found that participants responded faster when the movement direction of their body (e.g. moving *towards* the body to press the button) is consistent with the movement direction of the object that is specified in the sentence (e.g. you *opened* the drawer). Movement direction is not always necessary – language comprehension can also activate perceptual symbols. Zwaan et al.'s study (2002) conducted a speeded recognition task and found an interference effect between the *implied* shape conveyed by a sentence (e.g. the eagle is in the sky) and the *pictured* shape indicated in a visual image (e.g. an eagle with outstretched wings). The response speed of participants was faster in the matched pairings of implied shape and pictured shape than mismatched pairings. Inspired by this response paradigm, a large number of studies (e.g. Marks, 2004; Eitan & Granot, 2006; Küsser, Tidhar,

Prior, & Leech-Wilkinson, 2014) have been conducted to test cross-modal mappings between musical pitch and volume, and physical shapes, size, and height, etc.

Additional strong support for embodied cognitive theory is provided by increasing evidence from neuroscience studies. Lakoff (2012) explained the application of the neural theory of thought and language (NTTL) to the embodied account of an abstract concept. He argued that thoughts are physical and are carried out by functional neural circuitry in our brains; however, it is the ways in which these neural circuits connect and interact with the body that makes the thought meaningful and embodied. Take the example of the metaphor: 'He is a *warm* person'. This results from the activation of neuronal groups that happens simultaneously in two distinct regions of the brain – the one that relates to emotion and the other that relates to physiological response (i.e. temperature, blood pressure). In other words, the concept of affection is established through connections with bodily experiences. Gallese and Lakoff (2005) reported that we use the same brain resources for both imagining a movement, and for observing and making that action. For instance, the action concept of grasping, is presumed to be accomplished by a set of parameters which have constructed a so-called schema that includes elements such as agent-object-location, manner, purpose, and phase. Gallese and Lakoff (2005) further argued that all concrete concepts of whatever we can touch, smell, or manipulate, can be explained by such as schema.

Interestingly, the link between language and the motor system is present even when we hear someone speaking, not just in written language. For instance, a study conducted by Tettamanti and his colleagues (2005) confirmed that listening to action-related sentences (e.g. I grasp a knife) is associated with an activation of the left-lateralized fronto-parieto-temporal system in the brain which has also shown to be activated when executing or planning actions. By using abstract sentences as a control, this study demonstrated that activation was only present in areas of the brain not related to action when hearing an abstract sentence (e.g. I appreciate sincerity).

The literature reviewed above has implications in the musical teaching context. Music lessons are the places in which musical knowledge is understood via the mutual interaction between language, sounds, and bodily movements. The embodied hypothesis of language explains language processing and its connections with sensorimotor experience: language communication and understanding between teachers and students is not through a symbolization process that works independently of the body; but rather through a simulation of embodied experiences. Music teachers should not ignore the fact that much of the understanding of abstract concepts in language relies on embodied experiences. Music teaching should focus on the development of bodily and situated knowing, in order to gain more advanced and complex musical knowing. The Dalcroze approach used in musical teaching is a useful example in terms of developing bodily knowledge to learn musical knowledge (Juntunen & Hyvönen, 2004), for example concrete bodily movement (e.g. stretching or closing arms) helps students to understand musical structure and meaning (e.g. mode & mood).

The teaching and learning of piano timbre can work in a similar way. Piano timbre may be referred to using abstract adjectives (e.g. round, bright, etc.) or production-oriented instructions (e.g. lift your arm) in lessons. An embodied perspective to understand the teaching process involves using a student's bodily knowledge (sound-producing gestures, utilisation of the body) to help construct the meaning of language, which in turn reinforces the connection between the comprehension of verbal instructions and sensorimotor knowledge. Considering the example of 'a violin-like sound' described by a piano teacher, it is possible that the student will recall an internal simulation of both motions (i.e. bowing actions) and perceptual attributes (i.e. a long-lasting tone). When acting out the imitative intention on the piano, the student needs to translate these motions (i.e. pressed touch, speed, force) and the sonic effect (i.e. tone duration, intensity) on the piano. During this process, the connection between sounds, movements, and language is reinforced and

recycled in the student's learning. Thus, language is not simply a literal device (i.e. disembodied) without relevance to bodily movements (see Zbikowski, 2008).

Another type of language in piano lessons can be quite literal, for instance historical analysis or formal analysis of the musical piece. Teachers or performers may start from the historical analysis or formal analysis of the musical piece to provide students, or themselves, with a background understanding of musical interpretation, and then work on timbral targets more specifically. This type of language is less action-oriented compared to verbal instructions on playing techniques, but still may have an impact on embodiments in musical performance. For example, the study by Caruso, Coorevits, Nijs, and Leman (2016) found that a pianist explicitly changed the performance model and refined sound-producing and -facilitating gestures to align with her historical knowledge and acculturation in learning and playing Indian music on the piano, as an *enactive process* of translating interpretative intentions to the articulating body (Leman, 2016).

3.3.2 Concepts are embodied

The previous section reviewed the existence of embodied language, either written or spoken, especially in sentences that contain action words. Either concrete concepts (e.g. trees, cats etc.) or abstract concepts (e.g. ideas, metaphors) can also trigger internal sensorimotor simulation (see Gibbs, 2006), no matter how it is presented in a language content. This section will focus on the explanation of abstract concepts, as this study holds that the concepts that relate to piano timbre are mainly abstract, for instance the metaphorical descriptions of 'good', 'bright', or 'round' timbres. It aims to highlight the role of bodily movements and experience in the meaning construction of these abstract timbre concepts.

Differences between concrete and abstract concepts should be emphasized: an abstract concept refers to entities that have no physical or spatial constraints because there are no direct representations in the physical world; this is different from the notion of a concrete concept that

has physical or spatial constraints such as a tree, or the action of kicking (Zwaan & Taylor, 2006). Perception of piano timbre, or tone quality, usually functions as a mental concept that guides the performance or works as a conceptual structure of auditory experience, and hence is abstract in nature. According to embodied cognitive theory, the central argument would be that the timbre concept is embodied by bodily movements. This section will continue to argue for the embodied perspective on abstract concepts by reviewing a series of empirical studies and indicating their implication for piano timbre studies.

Casasanto and his colleagues have shown how motor activity can shape the understanding of abstract concepts such as goodness, badness, time, and space etc., and have tested the hypothesis largely on the basis of the handedness (see Casasanto, 2009, for a review). They have called this the body-specificity hypothesis – the assumption that people form different neural and cognitive representations of concepts and word meaning, given the fact that these concepts are simulated by individual actions and perceptions as each person interacts differently with the physical world around them (Casasanto, 2009). For example, a valence-space association was found in the results, in that people tend to associate the space of their dominant hand with more positive ideas (e.g. more attractive or intelligent). Similar research has also confirmed that graspable objects in a person's dominant space felt and looked much smaller and appeared more reachable (Linkenauger, Witt, & Proffitt, 2011). They also found that valence-space association could be acquired after short-term training, where the dominant hand of the participant was injured and reverse space-valence association started to appear, and positive ideas were more likely associated with the space of the non-dominant hand (Casasanto & Chrysikou, 2011). The body-specificity hypothesis explains the individuality and subjectivity in a pianist's understanding of the concept of piano timbre. According to MacRitchie (2015), each performer has distinct biomechanical features (e.g. hand size, finger length etc.), resulting in individual patterns of interaction between the body and the instrument during piano performance. For example, a timbral feature of a musical passage with

arpeggio chords may be described and experienced differently by a shorter pianist who has to use and move the entire upper body and a taller pianist who can use the shoulder/arm weight and move less to play the broken chords.

3.3.3 Conceptual metaphors

Language that is used to communicate and comprehend piano timbre is not always descriptive in a literal sense. This section will focus on the use of metaphor, or metaphorical thinking, in a musical context. Just as in an everyday context where people tend to say, 'The weekend has finally *arrived*' and 'I *got lost* in the idea', musicians also tend to describe their musical thoughts and experience by referring to concrete physical experiences, for instance: 'Making a *singing* tone' or 'The music *goes into* my heart', or even some descriptions that might not initially appear to be metaphorical, such as: 'The concert *comes to* the end.' Lakoff and Johnson (1980) defined the nature of metaphor as 'A IS B', which means: 'The essence of metaphor is understanding and experiencing one kind of thing in terms of another' (p. 5). The metaphorical thinking process reflects how humans understand and characterize abstract ideas. The central argument in this section is that metaphors or metaphorical thoughts that are integrated into everyday language and used without our notice are grounded in physical experience. This idea has been investigated by researchers, and will be reviewed below.

The embodied nature of metaphors has been thoroughly explained in *Metaphors We Live By* (Lakoff & Johnson, 1980), which demonstrates the role of physical bodily experience in the construction of abstract thoughts such as emotions and political words. Take the English expression 'argument is war' for example, the correlation between these two independent events is due to their shared structure: we gain or lose, attack or defend when we try to win either an argument or a war. This type of metaphor is called a *structural metaphor* by Lakoff and Johnson (1980) because we use one concept from a physical/cultural domain (i.e. war) to structure a concept from another cognitive domain (i.e. argument). The second type of metaphor is a *physical*

metaphor, enabling us to view abstract concepts (i.e. emotions/ideas) as entities or substances for grouping, categorizing, and quantifying purposes (e.g. 'too much pressure'), but this type of metaphor is too common and we hardly notice it. The last type is an *orientational metaphor* most of which have to do with spatial orientation (e.g. up-down, front-back, in-out, central-peripheral etc.). According to Lakoff and Johnson (1980), we heavily rely on the up-down metaphor to express many concepts due to a physical and cultural basis, e.g. emotions (cheer up vs. feel down), power (control over vs. under control), consciousness (wake up vs. fall down), and fortune (income rises vs. falls) etc.

Lakoff and Johnson (1980) explained the 'verticality schemata' and its relevance to musical pitch (pitch is high or low), and even emotion (e.g. happy is 'up' while sad is 'down'). The embodied experience of verticality in musical pitch might be that we have the embodied experience of seeing the physical location of pitch in musical notation. The evidence regarding emotion may be that our body language shows when we are experiencing happy and sad feelings, by 'standing tall' or slouching respectively (Casasanto & Gijssels, 2015).

Gibbs, Lima, and Francozo (2004) explained the notion of 'image schema' in the conceptual structure of abstract concepts. Image schemas are the embodied basis for human abstract concepts and metaphorical thinking processes which emerge during sensorimotor activities when manipulating and interacting with objects both temporally and spatially. They gave an example of 'momentum', as language that enables us to understand and communicate very abstract political ideas: 'I was bowled over by that idea. We have too much momentum to withdraw from the election race. I got carried away by what I was doing.' In this sentence, the **idea** serves as an **object** which contains a degree of momentum and has an influence on the speaker – the bigger the idea is, the more momentum it has; and when the big object (idea) encounters an agent (the speaker), the agent will be carried away. Additionally, we experience momentum with multisensory dimensions, either through the visual modality (seeing heavy objects), kinaesthetic

modality (moving heavily), auditory modality (simply hearing louder sounds), or by integrating visual and kinaesthetic information.

The use of metaphorical description in music is one of the ways in which language describes musical response; the other one is literal description (Zbikowski, 2008). Zbikowski (2002) suggested that a musical concept can be associated with other concepts, in which case, connection may be established via bodily involvements (physically or emotionally), with perceptual or linguistic contributions. For example, musical pitch is described as 'high/low' or 'thin/thick' in different cultures; in this case, the correlation between the musical domain (pitch perception) and physical attributes (verticality, sharpness, thickness) is established. This process is called cross-domain mapping, namely the mapping between the target domain (i.e. pitch) and the source domain (i.e. physical space). Its function in musical understanding is summarised thus:

> First, it provides a way to connect musical concepts with concepts from other domains, including those associated with language; second, it provides a way to ground our descriptions of elusive musical phenomena in concepts derived from everyday experience. (p. 77)

Another music example regarding embodied metaphor is 'musical motion', relating to the mysterious phenomenon where we tend to describe music as moving (i.e. pitch rising or falling), when the fact is that none of the musical notes are actual moving. Johnson and Larson (2003) claimed that people's understanding of musical motion is entirely metaphoric, and that key metaphors are based on our experience of physical motion. We utilise body-based conceptual metaphors to comprehend and reason about musical motion. The source domain, the layer where we tend to map our abstract experience of musical motion, is motion in space. Learning about space and physical motion should be crucial to how we experience and think about musical motion.

3.3.4 Intermediate summary

Above sections have highlighted the importance of the motor system and environmental experiences in shaping our linguistic and cognitive structures. To bring relevance to the studies of piano timbre, this research will argue that language and concepts that relate to piano timbre are constituted via bodily movements. Take the example of a 'round' sound – pianists understand this phrase by physically playing it on the piano and getting both auditory (i.e. what it sounds like), visual (i.e. what the finger/hand is like), and other sensory feedback (e.g. bodily tension and relaxation, weight, force, and energy, as well as awareness of bodily movement direction, size, and temporal features). Thus, language, action, perception, and meaning are successfully integrated in this process. This challenges the disembodied perspective of music and language that pianists are constructing or duplicating an internal representation of a concept in order to make the symbols meaningful so that a mental process can work independent of the body and the brain. Instead, pianists understand language via a coupling between action and perception, gesture and sound, and physical experience and meaning. Once the motor-sensory association is established in the performer's experience, it can operate in multiple directions, in the sense that a pianist can generate an auditory expectation of a rounded sound in either observed physical movements or imagined physical movements; they can also simulate the physical movements of performance actions when hearing a round sound.

Apart from the music-gesture interaction in music-making processes, the everyday physical experience also helps humans to establish a cross-domain mapping between the abstract musical experiences and concrete physical experiences. The habits, preferences, and situations where two domains connect are varying and may be inconsistent. To illustrate the metaphor of 'Argument is X': an analogy of *a war situation* is used in the utterance of 'He attacked my weak point' or 'Your claims are indefensible'; an analogy of a *building* is used in descriptions such as: 'We've got the framework for a solid argument'; an analogy of a *journey* is referred to when we

say: ‘So far, we haven’t covered much ground’ (Johnson & Lakoff, 1980, p.98-99). This explains the phenomenon of the wide range of timbre descriptors indicated in the linguistic approach to study piano timbre, which uses a variety of physical attributes for concepts such as texture (dry, velvety), shape (round, sharp), weight (heavy, light), as well as cognitive dimensions such as valence (bright, dark) and tension (relaxed, tensed).

Returning to the question of what we perceive in piano timbre – of whether timbre is a solely auditory phenomenon, this section on embodied metaphor offers new insight in the sense that we are interested in what is being expressed through piano timbre, and are good at associating their familiar experiences and feelings with sound phenomena. This is why we tend to map the perceived timbral qualities onto ordinary physical experiences such as walking, singing, and speaking. The common features between these activities help us to understand and describe sounds. Also, last but not least, timbre-related motor-sensory association experience can be individual and unique to different pianists and listeners, depending on the mental patterns of how they tend to associate a target domain with a source domain. This explains why some timbre descriptors are meaningful for some pianists but may be not appropriate for the others – which adds a degree of subjectivity in verbal descriptions of piano timbre.

However, criticism of the embodied approach to study cognition is continuing. In the context of linguistic studies, a number of researchers have argued that the embodied hypothesis cannot explain everything involved in language processes; that there are external, abstract, and symbolic representations involved in the process of making language comprehension complete and full (see Kaschak, Jones, Carranza, & Fox, 2014 for a review). Despite the ongoing argument, this research will continue to assert the embodied approach to piano timbre, since it explains the close association between physical movement and conceptualisation process of piano timbre. Additionally, it helps to investigate performer-controlled timbre, in which context the rich

existence of bodily causality on the piano sounds leaves a number of interesting questions to resolve.

Bodily movements in piano performance are complex and subtle, for instance touch qualities. In order to understand how and to what extent bodily movement contributes to the understanding of musical sounds, we have to understand what types of movement need to be considered in musical activities. The following section will elaborate on the features and functions of bodily movement in musical performance.

3.4 Movement in Musical Performance

Movement is not only responsible for producing sounds; it also has a communicative function in the communication between performer and audience. The terminology of 'musical gesture' needs to be employed when we talk about the meaning and social/cognitive function of physical movements in musical performance. As highlighted by Rosen (2002), gesture is part of piano performance and musical interpretation, as it conveys the performer's intentions to the audience:

> I do not wish to defend the more extravagant gestures, but I have found that even the most emphatic final cadence will sometimes not convince an audience that the music is finished; without some kind of visual indication, the applause all performers hope for will be late in coming and more tentative than one would like. (p. 30)

Jensenius, Wanderley, Godøy, and Leman (2010) categorized music-related gestures into four domains based on an existing framework from gesture studies, namely: sound-producing gestures, communicative gestures, sound-facilitating gestures, and sound-accompanying gestures. According to Jensenius et al., (2010), sound-producing gestures are the movements that effectively produce sounds; communicative gestures are semiotic gestures that aim to communicate between performers or to audiences; sound-facilitating gestures are ancillary gestures that support the sound-producing gestures; sound-accompanying gestures are not involved in the actual sound-production process but follow the music sounds, for instance dancing.

As they have indicated, there is no a clear-cut distinction between these four types of gesture; some movements are sound-producing as well as sound-facilitating while also having communicative functions. For example, in the context of piano performance, pianists primarily move their fingers but also coordinate movements of the head, torso, and sometimes the lower part of the body; a piano performance depends on the speed, weight, force, and effort they execute in their performance. The most obvious sound-producing movement is that of striking the keyboard using certain finger-touch qualities, but pianists do not only move their fingers: the wrists and arms will join in to facilitate and coordinate the movements, and the head and shoulders may circulate or swing to accompany but also to initiate the played sounds. 'It is the preparatory movements of this complex multi-joint system that determine the trajectory and velocity of the finger before and after it hits the key.' (Jensenius et al., 2010, p.26). From the performer's perspective, the fluidity and coordination between different joints is a crucial part of musical gesture, as it relates to the sound production and modification process and influences the quality of the performed sound.

From the perspective of listeners, the coordination of different types of musical gesture has an impact on the perception of the musical performance. Rather than perceiving a continuous ongoing stream of gesturing and sound, listeners tend to segment movements and sound into a series of events or chunks which range from 0.5 to 5 seconds (Godøy, Jensenius, & Nymoen, 2010). For example, Godøy and his colleagues (2006b) observed the movement of listeners in air piano performance, and found that sweeping scales are rendered as sweeping hand, arm, shoulder, and torso movements by listeners. This phenomenon has been well researched by Godøy and his colleagues in relation to the notion of 'coarticulation' and 'chunks' in musical gestures. The notion of coarticulation is borrowed from linguistics studies, where it is used to explain coarticulated phonemic gestures in relation to continuous speech (Hardcastle & Hewlett, 2006). Coarticulation also occurs naturally in music-related actions, when the movement of one effector (e.g. the finger striking the piano, or the hand in creating chords) 'spills over' into neighbouring parts of the body,

and these movements will be embedded in a temporal manner (Godøy et al., 2010). Another feature of coarticulated gestures is characteristic temporal development of motion, in the sense that past events influence present events, as well as future events affecting present events. For example, the positions and shapes of effectors are affected by recent actions and also determined by future actions (Godøy, 2013).

This gestural categorization is important in explaining piano timbre-related performance gestures. Researchers have paid extensive attention to touch quality in the studies of piano timbre perception and production (see Chapter 2, Section 2.3.1). However, they tended to neglect the bodily aspects of movements that facilitate, modify and refine the sound-production process. As Jensenius et al., (2010) stated, the gestural typology is not intended to establish an absolute classification system, but to highlight the differences in the function of musical gestures. In the production of piano timbre, the finger stroke is one of the most observable effectors, but the coarticulated wrists, arms, and torso also influence the production process. Performance gestures might have varying levels of impact on the listener (i.e. some gestures tended to be more communicative while others are effective sound-production actions); for performers, however, the physical production process is a holistic unit that unfolds movements in a temporal and spatial manner. Therefore, it is possible to assume that the corporeal experiences that are associated with timbre perception extend from singular effectors (e.g. finger) to a unit of relevant bodily movement and consist of complex and dynamic kinaesthetic experiences of direction, shape, weight, effort, tension etc.

The notion of 'coarticulation' and 'chunks' contributes to the understanding of how people may perceive timbre-related actions. As we may notice, people tend to describe perceived timbral effects based on an impression of a musical phrase, or occasionally based on singular tones. Sophisticated piano techniques are required in piano performance when playing fast musical passages, but pianists often tend to practice and develop their motor skills at a slow tempo and

then speed up to achieve a certain degree of motor fluency and coordination. Additionally, different skills are required of either hand in a polyphonic performance context. Figure 3.1, an excerpt from 'The Swan' (composed by Saint-Saens in 1886, and adapted for piano solo) illustrates the extent to which sound-producing actions and sound-facilitating actions coordinate and change when playing at different tempi. When the music is played at a slow tempo, finger movement is the significant effector – in which context, the fingers will move individually together with a large extent of wrist fluctuations. As the performance tempi accelerates, the movement chunk will appear in both hands: the wrist of the left hand starts with a circular motion and horizontal rotation, while the fingers do smaller trembling motions, while the right hand executes a smooth but lasting movement to create the melodic line. Timmers, Ashley, Desain, and Honing (2002) have found an influence of musical tempi on pianists' choice of categories of grace notes (i.e. on-note, pre-note, or insertion) in piano performance, which is contrary to the study of Repp (1994) that there is a fixed proportion between relative durations of notes and of the whole piece no matter what musical tempo. The above studies imply that pianists' perception and production of piano timbre may depend on other performance parameters such as performance tempi, as distinct movement patterns may get involved .

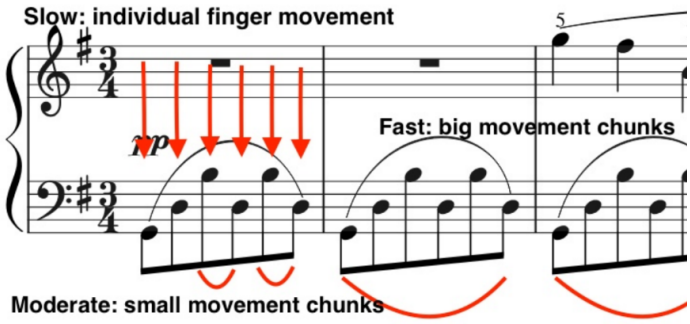


Figure 3.1. The movement chunk when playing 'The Swan' at slow, moderate, and fast mode. This arrangement is adapted for piano solo version.

3.5 Mechanisms and Key Concepts

Two key mechanisms that explain the nature of embodied music cognition will be explained, namely the action-perception coupling and mirror neuron theory. The literature review will not be limited to the summary of empirical studies in the musical field, but also including evidences of cognitive science and neuroscience studies. Given the fact that neither of these two notions have been used to explain the perception of piano timbre, this section will include my own reflections on the possible contributions and implications into the study of piano timbre.

3.5.1 Action-perception coupling mechanism

The theory of an action-perception coupling mechanism helps us to understand to what extent, and how, physical action contributes to musical concepts and informs perception. As summarised by Maes, Leman, Palmer, and Wanderley (2014), the planned action and the relevant sensory (auditory and visual) outcomes of that action are coded in the motor and sensory brain areas respectively; motor and sensory representations are integrated in this process, which leads to an internal association between action and perception. More specifically, sensory outcomes can be inferred from the pianist's own physical actions or the observation of planned actions of others (i.e. from action to perception); motor commands can be planned and prepared for based on sensory outcomes (i.e. from perception to action). One of the cognitive functions of action-perception coupling in music performance is to generate predictions based on the pianist's own observations, as well as on the actions of others (Novembre & Keller, 2014).

Researchers have paid particular attention to the inverse pattern of the action-perception coupling cycle: i.e. interference between presented sensory outcomes and presented or planned hand position. This capability is developed in instrument-specific training, relating to so-called 'action-effects'. Behavioural studies used interference paradigms to examine the association between hand position and the corresponding sound outcomes; interference was observed when auditory feedback was incongruent with the corresponding result of a motor input. Drost and his

colleagues found that pianists establish a strong association between the hand and the ear in the production of pitch (Drost, Rieger, Brass, Gunter, & Prinz, 2005a) as well as timbre (Drost, Rieger, & Prinz, 2007), since the interference effect did not happen in non-musicians and guitarists under the same experimental manipulation. Neuroscientific studies have shown that the motor and premotor regions of pianists' brains were activated when listening to unfamiliar piano sequences, unlike those of non-musicians; in addition, it was shown that auditory-related regions were also activated in response to a visual presentation of musical action or hand movement without auditory feedback (Bangert et al., 2006). It has been found that this coupling can be established after five weeks of keyboard practice in non-musicians (Bangert, Haeusler, & Altenmuler, 2001).

Inspired by the action-perception coupling theory is the idea that awareness of timbre is one of the auditory outcomes that are produced by a particular action. Piano timbre concepts can be understood as a product of musical training on touch quality and bodily coordination. However, there have been few empirical studies on the idea of timbre perception in terms of the sensory-motor association pattern, unlike other musical elements such as pitch (Drost et al., 2005a), melodic direction (Taylor & Witt, 2015), and harmonic expectancies (Koelsch, Schmidt, & Kansok, 2002).

The reason for this lack of investigation has been revealed by several researchers: timbre as a fourth attribute of tone, along with pitch, volume, and duration, is difficult to manipulate due to its multidimensional nature, and has no widely-accepted definition from which scholars can develop an experimental approach (Hajda et al., 1997). The ability to create and change the sound colour on a piano needs years of practice and training; whereas the production of pitch is quite simple since the pitch of the keyboard is already fixed, and the association between hand location and pitch perception can be established after a short training session (as shown in Bangert et al., 2001). Finally, there is no agreed syllabus on how to teach or produce certain timbral intentions, therefore, there is no generally accepted pattern of sensory-motor activity relating to timbre

production. However, the relationship does exist and can be recognized with individual patterns for pianists.

3.5.2 Mirror neuron theory

The mirror neuron theory helps to explain the mechanism of how we can understand other's actions, intentions, and emotions. The evidence of mirror neurons was firstly found in monkeys and it was discovered that the F5 area in a monkey's brain is activated when the monkey performs a particular action (e.g. grasping), as well as when it observes a human executing a similar motor act (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996). A follow-up study further demonstrated that the mirror neurons of monkeys can also be activated just by hearing the sound outcome that is generated from an action (Kohler, Keysers, Umiltà, Fogassi, Gallese, & Rizzolatti, 2002). The same experiments on humans confirmed that the human mirror neuron system (MNS) also showed sensitivity when observing the actions of others (Iacoboni et al., 2005) or hearing action-related sounds (Buccino et al., 2005), therefore indicating the importance of the MNS in representing actions and intentions of others by recruiting from one's own motor system. Last but not least, MNS may also be involved in empathy – the ability of humans to understand the emotions of others, because of the 'motor identification' of facial expression associated with certain emotions (see Fogassi, 2013).

Interestingly, there is a first-person principle in the activation of mirror neuron areas: the mirror mechanism relies on the first-person knowledge, which normally occurs when observed actions are already present in the observer's motor repertoire (Buccino et al., 2004a). In a brain-imaging study conducted by Buccino and his colleagues (2004), it was found that the human MNS responds differently to two types of gesture (biting and communicating) performed by either a man, a monkey, or a dog. Mirror neuron areas (especially inferior frontal gyrus) of observed participants are activated when watching the eating behaviours performed by either the man, the monkey, or the dog. In contrast, the activation of mirror neurons was much weaker when responding to communicative behaviours performed by the non-human species (e.g. a dog barking or a monkey

lip-smacking). This study implies, therefore, that musicians whose motor repertoire is richer due to their interaction with musical instruments, will respond differently to non-musicians when listening to musical sounds, or watching a performance. They can engage in the music from a more 'first-person' perspective, having reactions in the motor areas in their brains in response to another's performance.

The above evidence has indicated that mirror neuron areas of the human and monkey brains do not only respond to actions (either observed or performed), but also sounds that are associated with actions. This finding has great implications when applied to the musical context, as music sounds are indeed sonic events. When listening to musical sounds, intrinsic associations between music and motion have been found both externally (e.g. our movements make sounds) and internally (e.g. a sense, or mental images, of moving). One of the main contributions made by Godøy to this field is his idea that the sound-producing action (e.g. hitting, bowing, striking etc.) contributes to the human mental image of the sound, in the sense that we depict the sound-production gesture as a part of the perceived sound and use it as a memory trace for that particular musical sound (Godøy, 2001; 2003; 2010). Even though these studies did not explicitly refer to MNS, I would argue that mirror neuron theory helps to explain how the human motor system works internally in response to musical sounds.

Iacoboni and his colleagues (2005) raised the question of whether the MNS works merely in understanding actions, or whether the embedded context has an influence on action recognition. For example, the authors proposed that when we observe someone grasping an apple, the MNS can work very well to explain the comprehension of motor activity in the action of grasping (i.e. 'what' is an action), but it is still unknown whether the MNS can enable us to understand whether the apple that has been grasped is to be given to someone else, or we will to eat it ourselves (i.e. the 'why' of an action). They conducted an experiment to examine the influence of different contexts (e.g. drinking context before tea vs. cleaning context after tea) on the activity in mirror

neuron areas when observing the action of grasping a tea cup. If the MNS understands not only the observed action but also the ultimate goal, then activity in the mirror neuron areas should be influenced by the presence or absence of the context. Their research findings confirmed the assumption that the role of MNS in the understanding of actions can be extended from action recognition (to grasp, to hold, or to bring to the mouth) to understanding of intention (e.g. to drink, or to clean). Detecting the ultimate goal of an action is of crucial significance in our everyday lives, but this function needs the activation of the mirror neuron areas in response to a specific motor act as well as contextual information to operate the inference process (Fogassi, 2013). In a musical context, the intention of action is to generate sounds that can vary in pitch, dynamics, duration, and timbral qualities etc. By interacting with the instrument in a creative way, sensorimotor experiences are generated and developed in the performers' mirror neuron areas so that they can understand the actons and intentions of their own and others in a meaningful way.

One of the applications of mirror neuron theory in the musical context is to explain the process of learning an instrument. The learning of an instrument starts with an imitation of other's actions. Buccino et al. (2004b) examined the role of MNS in the imitation of other's actions by conducting an experiment in which musically naive participants were required to observe the hand positions of an expert guitarist and then imitate that action after a short pause. This study found that the MNS relates to all phases from action observation to action execution; to translate visually coded actions into motor representations in the motor area of the brain and then to execute the action sequence. However, as Leman (2008) has argued, the learning of a musical instrument also involves the learning of new patterns and is not merely imitation. Apart from motor knowledge, the brain also has to learn how to integrate visual information with the sound. The function of MNS is still unclear regarding the learning of new patterns, and needs further investigation in neuroscience studies (Leman, 2008).

In a musical context, as listeners, we can ‘stand in someone else's shoes’ to understand the actions, emotions, and sounds of performers by simulating the motor activity. According to Molnar-Szakacs and Overy (2006), ‘a similar or equivalent motor network is engaged by someone listening to singing/drumming as the motor network engaged by the actual singer/drummer’ (p. 236), and therefore musical listening is not simply a perception of acoustic patterns in musical sounds. To apply this explanation to the perception of piano timbre, listeners can understand the expressive intentions of performers by internally simulating the motor sequences associated with the timbre quality. For example, when hearing a ‘light timbre’ in a piano performance, the listener experiences similar motor activities in the brain as the pianist does in executing the actual movements (i.e. gentle finger striking, smooth elbow movement), which enables the musical communication to occur on the basis of a shared representation of actions and intentions. In this context, the MNS works in a listener’s brain to associate action, sound, and artistic intention. Non-pianist listeners can also have a similar experience but this is not necessarily consistent with the artistic intentions of the performer. Non-pianist listeners may not be able to understand specific gesture-intention associations because of a lack of motor repertoire, but they can still experience the music with a global feeling of quality, whether beauty, elegance, peace, stillness, power or otherwise.

However, this research acknowledges the limitation of exploring MNS in the studies of piano timbre. This is due to a smaller degree and variety of bodily participation in classical music compared to the physical activity generated by other musical genres such as rock, jazz, pop music, and dancing etc. A pop singer can integrate head nodding, swinging, hand waving or flying movements as communicative gestures into his/her performance and create a shared cultural experience with their audience (see an illustration on Davidson, 2006); both will know and understand what the exaggerated or personalized gestures mean. Nevertheless, the MNS is still crucial in explaining the powerful connection between performers and listeners during a musical

performance, as it allows listeners to experience similar power, emotion, force and tension as the performer does in the music.

3.6 Summary

This chapter has examined the applicability and feasibility of the embodied approach to the study of perception and production of piano timbre. The central idea is to understand the integration of the mind and body in musical understanding, music perception, and the music-making process. Mind-body integration has great importance in musical practice and music education; neither the mind nor the body has a higher function and superior place in the music-making process, and neither of them can work independently of the other. Putting this into the context of music research, the relevance of the performing body to musical expression, communication, and meaning formation becomes important. Timbre descriptors may not only be related to perceived acoustic qualities, but also associated with physical and physiological responses in the music production process. Gestures and movements of the performer prior to the striking of musical tones or after the releasing of musical tones, may also be regarded as an integrated part of the perceived tone quality. The theory of action-perception coupling affords a powerful theoretical explanation of the mechanism of integration between gestural control (e.g. sound-producing gestures, communicative gesture) and sonic outcomes (e.g. timbral effects).

This chapter also gives a foundation to the explanation of embodied learning and embodied listening in a musical listening and education context (see Chapters 4 and 5). The notion of internal motion simulation and the MNS to explain the processes of how humans understand other's action intentions forms part of the foundation of my second empirical study (Chapter 8), to explore the role of the visual component of music performance. In this case, piano timbre is studied from the viewpoint of whether a shared understanding of the gesture-sound relationship exists between the performer and listener. In addition, the view that 'conceptual metaphor is grounded by bodily

experience' helps to explain the extensive utilisation of metaphor and sound demonstration in the teaching and learning of piano timbre (Chapter 9). Here, an embodied approach to the study of piano timbre aims to explore the processes by which a shared understanding of abstract concepts and participatory sense-making is generated procedurally, emergently, and creatively between the teacher and the student.

Chapter 4: Timbre Production in a Musical Context: Communication, Expression, and Audio-Visual Presentation Modes

4.1 Introduction

Chapter 3 explored the relevance of the human motor system to timbre perception, and proposed the central argument that the concept of piano timbre is embodied in piano performance via bodily movements. Complementary to the internal mental conceptualisation process, this chapter will focus on the perception of piano timbre from the viewpoint of the audience (i.e. seeing and/or hearing piano performance). It will explore the following questions: Do pianists communicate timbral intentions (e.g. round timbre, bright timbre) in their musical performance? If so, what is the relevance of the auditory and/or visual component of musical performance? What is the similarity/dissimilarity with emotional communication (e.g. happiness, sadness) in music? Is perception of piano timbre a cross-modal experience, similar to the perception of musical pitch and intensity?

Studies of the audio-visual presentation of musical performance have investigated its impact on perceived expressiveness (Davidson, 2005), musical appreciation/evaluation (Platz & Kopiez, 2012), and emotional aspects of music (Timmers, Marolt, Camurri, & Volpe, 2006; Dahl & Friberg, 2007). However, little is known about whether a precise timbral intention by a pianist can be communicated to listeners, or about the role of visual or aural cues.

This literature review will start with how communication is defined, and will consider several models of musical communication that are concerned with performer-listener relationship. The aim is to explore what timbral communication may refer to, and which models of musical communication are better established to explain timbral communication. Apart from the performer-listener relationship, the literature review also considers performer-music

communication by investigating motivation and the significance of expressing timbral intentions in piano performance. From Section 4.3 onwards, there will be a focus on reviewing empirical studies concerned with musical communication and audio-visual presentation of music performance. The aim is to seek appropriate experimental paradigms for my second empirical study – a perceptual experiment of piano timbre from the viewpoint of the listener.

4.2. Communication, Expression, and the Relevance to Piano Timbre

4.2.1 Music Communication: from information-processing to interactive

A definition of communication has been given by Johnson-Laird (1992): He states that communication is a matter of causal influence, but that it also calls for something else: 'The moon causes tides' only reflects a causal relationship and is not a matter of communication. Johnson-Laird (1992) claimed that the communicator must have a message to transmit, and the whole communication process is described as: the communicator will construct an internal representation of the external world, and then convey the meaning by extracting some symbolic behaviours. What the receiver does is to encode these behaviour and further recover an internal representation of the message it signifies (ibid). However, the application of the 'from sender to receiver' model to the study of musical communication has been criticised by several scholars (Cross, 2005; Cohen, 2005) with respect to its one-directional feature, which neglects the role of the active contribution of the listener – their cultural background, for instance – in shaping the content and meaning of conveyed messages.

Music communication has been compared with language communication with regard to their similarities and dissimilarities. Undoubtedly both music and language communicate emotion and intention and share certain features, for instance: melodic patterns (pitch contour), rhythmic patterns (accents in speech and music), and timbral contrast; however, a remarkable difference has

been pointed out by Cross (2005) in terms of an ambiguity in music communication that is not present in speech:

> Whereas in language it is usually possible to specify the subject of an utterance with some precision, this is almost never the case for music. Music appears to be a strongly malleable and flexible phenomenon. The meaning or significance of a musical behaviour or of a piece of music can rarely be pinned down unambiguously; music appears to be inherently ambiguous. (p. 30)

According to this statement, this ambiguous feature in music communication has left a rich space for performers to interpret their own expressive ideas in musical performance which may differ from the composer's intention; and also for listeners, who may understand and construct meaning and experience from musical sounds that might, or might not be, consistent with the performer's intentions.

Models of music communication have also experienced a shift away from a purely information-transmission model, and have focused on a more dynamic and interactive paradigm. Typical models that addressed the relationship between the composer, performer, and listener in music communication processes are listed and explained below:

- Shannon and Weaver (1949): A traditional information-theory model which explains that the information channel consists of elements such as the source, the message, the receiver, and the noise, which can prevent a perfect transmission. Moles (1958) has translated this model to a musical context explaining the message transition between the mind of the performer and the mind of the listener.
- Kendall and Carterette (1990): A model of music communication that addresses how the composer and performer convey their expressive intentions and how the

listener perceives the intended message from the composer/performer via message recording. The composer's encoding process goes from ideation to notation; the performer than recodes the notation into acoustical signals, and finally these acoustical signals are recorded by listeners and result in ideation. This study identified the performer's role as a message carrier who is a 'synchronous modulation of the composed states' (p. 135) and the role of the listener is to seek the musical meaning.

- Juslin and Lindström (2010): The expanded lens model, based on a previous lens model (Juslin, 2000). This expanded model integrates the composer's utilisation of cues (mode, pitch, melody, rhythm etc.) to convey an emotional message with the original performer-listener communication chain. This study claims that performers do tend to convey specific emotions in the musical performance; that listeners are expected to recognize that emotional intention, and that failure to do so implies an unsuccessful communication process. The research results indicate that both compositional and performance features have powerful effects on the emotional judgement of the listener, but that the interaction between these two features is not significant.

These models have acknowledged the objectives of different agents (composer, performer, and listener) in the musical communication process is to transmit a certain 'message' or 'intention', and the latter models suggest that each of these agents plays an active role in creating musical meaning in the communication process. However, these models seem to regard musical communication purely as a sonic art, as can be seen in Juslin's model of acoustic cues as a lens of musical expression, as well as Kendall and Carterette's model which regards the acoustic signal as a transmitter of composer/performer's thought to listener's ideation. This neglects the function of bodily communication in live musical performance, and the internal simulation of movement

when listening to recorded music. These elements are important in current research on music communication and have been referred to as 'extra-musical elements' by several authors (e.g. Bower & Swart, 2016) according to Godøy (2003).

In contrast, an embodied approach to investigate musical communication is concerned with corporeality in musical performance. Leman (2008) proposed a model of music communication based on the decoding and encoding of motor control. The author suggested that music encodes corporeal articulations into sonic form, which can be further decoded and anticipated by listeners. Listeners do not need to decode the musical meaning and experience in the same way as performers because they can relate sounds to their own action-relevant ontology. Performers will receive haptic, visual and sonic feedback from the mediator (i.e. the instrument) which can, in turn, improve gestural control and reduce the perceptual ambiguity of the relationship between performing action and sonic outcome.

Leman's (2008) model explained the relevance of the sound-gesture relationship from the viewpoint of both performers and listeners, and extends the understanding of musical communication from the decoding/encoding of sonic forms to include the decoding/encoding of motor control. However, the fact of the division between the mental representation of music (i.e. musical goals in the mind of performers) and the actual behavioural output in musical performance has been criticized by several scholars who are the advocates of the enactive cognition theory (e.g. Schiavio & Høffding, 2015; Schiavio & De Jaegher, 2017; Moran, 2011). Schiavio and De Jaegher (2017) selected the case of duet performance as an example, and claimed that playing together is not simply a 'sender-receiver' and 'stimulus-response' framework; instead, the shared meaning, intentionality, and experience are co-created and enacted in a manner of participatory sense-making: 'cooperative generation and transformation of musical meaning' (p. 34). This idea implies that experience and intentionality related to piano timbre may be an emergent production that

happens between the performer and the listener during the musical practice, and therefore, that timbral ideas do not necessarily need to be projected as mental states (e.g. representations) in the performers' head and then 'sent' to the listeners.

As a reflection of the literature review, this study will adopt a more embodied account to investigate the communication of timbral concepts in the piano performance. The reason is that an embodied account of musical communication has shed light onto the study of timbre perception with an emphasis on the sound-gesture relationship. This is in line with the ecological account of musical listening (cf. Clarke, 2005), by which this thesis will argue that the perception of piano timbral nuances extends from the perception of the physical attributes of sound, to a more meaningful thought by listeners on the specification of possible gestures/actions that cause or generate sonic outcomes. In the case of piano timbre, the communication process may be regarded as a meaningful event between performers and listeners who related gestural intentions to the wide variety of timbral nuances. Several scholars have begun to research the implications of such enactive accounts of cognition for music education (e.g. van der Schyff, 2017; van der Schyff, Schiavio, & Elliot, 2015). These implications will be examined in my third empirical study – the teaching observation study (Chapter 9), in which context timbral intentions may be enacted through real-time co-participation of both teachers and students.

It is also important to point out that this study is not aiming to ignore any connection between the traditional transmission models (e.g. Kendall & Carterette, 1990; Juslin & Lindström, 2010), and embodied/enactive models of musical communication, or to ignore the part that traditional models can play in explaining how timbral communication works. Rather, the traditional 'information-process' models of musical communication have influenced my experiment design, where the performers are required to play the same musical piece with different intentions of piano timbres to examine whether the listeners can recognise that intention (see

Methodology chapter, Section 6.3). In this situation, the listener's responses are the criteria of success of musical communication, e.g. whether a 'round' timbre expressed by the performed is correctly recognised by the listener or not, which leaves an impression to readers that listeners are the passive perceivers, but they are not: this study does want to acknowledge the active role of listeners in the musical communication process and in shaping what they perceive as musical expressiveness. They are not merely the receiver of messages of timbral intention--they are generating and constructing their own intentions by resonating perceived messages with their own educational, cultural, and musical-training backgrounds. For example, the contexts and situations within which musical communication takes place play a role in music perception (see Hargreaves, MacDonald, & Miell, 2005).

4.2.2 Expression: what pianists express about timbral intentions

It is not surprising that the studies of music communication mainly concern the chain of communication between performer and listener. Pianists do indeed communicate with their audience through a variety of piano timbres, but an implicit and hidden part of the communication chain which researchers often neglect is that pianists also communicate with themselves. They are both listeners and performers at the same time, and they too experience the sonic outcome of their own performance. The question then arises of what pianists themselves experience while producing timbral nuances in piano playing?

Rosen (2002) gave his answer by rephrasing the question: 'For whom do we play in public?' to 'For what does one play? – one plays for the music' (p. 124). Indeed, to rethink the objective of timbral communication, the performer may communicate to their listeners, but also may communicate with the music. According to Hargreaves et al., (2005), there is a reciprocal feedback between performer and music, during which performers may experience strong emotions while playing (i.e. both perceived and felt emotions) and communicate with feelings (Persson, 2001).

Subsequently they may experience similar induced physiological responses (e.g. increased heart rate) as listeners (see a review in Hodges, 2009). Other explanations may be that performers may take the perspective of an observers whilst playing: i.e. they are listening to their own performance as if taking a second/third-person perspective rather than a first-person perspective.

In order to understand what performers communicate in the production of piano timbre, a phenomenological perspective of the performers' personal feelings and engagement in music performance needs to be studied. Patricia Holmes and her colleagues conducted a series of studies to investigate the guitarists' communication of timbral intentions, from the performer's perspective. Holmes (2011) did an in-depth interview concerning the significance of, and motivation for, producing timbre for a guitarist; using questions such as: 'Are you aware of using tone colours in your performance?', 'Do you think tone colour is an important part of communicating music when you perform?', or, 'What about the effects of sounds on listeners?'. Her study found that the employment of specific timbres by a professional performer via the process of personal involvement and investment in the sound is directly connected to a sense of self-satisfaction and achievement. 'When musical goals are achieved, his (the guitarist's) emotional response clearly centres on feelings of satisfaction and occasionally elation, the intensity of which is generally dependent upon the perceived degree of task mastery – he (the subject) consistently referred to employment of specific timbres as a key element in this process.' (p. 316). Holmes' study suggested that for the communication of timbre, it is not necessary to face an audience; instead, the communication process can be fulfilled within the cycle of performer-music-performer, which can bring positive feelings for the pianist.

4.2.3 A critique on the framework of acoustic cues in musical communication

To give some background information, a common experimental paradigm to examine musical communication and expression relates to the notion of acoustic cues, which is concerned with the extent to which the expressive intentions of composers or performers are mapped into musical sounds and then transmitted to listeners. Within the scope of acoustic cues, timing and dynamics are the two most examined features in music performance studies, as well as intonation and vibrato. A number of empirical studies (e.g. Gabrielsson & Juslin, 1996; Palmer, 1989) have investigated performer-listener communication via examination of the audible and measurable differences of performance parameters. Figure 4.1 represents a 'lens model of musical communication' (Laukka et al., 2013), which explains the extent to which performers and listeners are sharing similar acoustic cues (dynamics, timbre, and register) and musical cues (rhythm, tonality, and structure) in undersetanding the expressed and perceived emotion in music performance. The main contribution of Laukka et al.'s (2013) study is to investigate the degree to which those cues are universally shared.

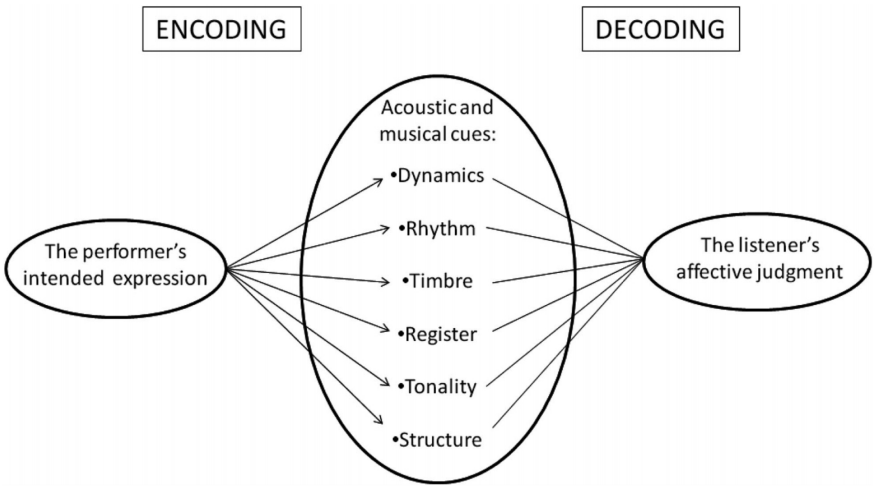


Figure 4.1. A lens model of musical communication as explained by Laukka et al., (2013)

In the lens model of musical communication, timbre has been clearly identified as an effective acoustic cue used by the performer to communicate emotional intention to the listener. However, timbre seems to work differently compared to parameters of timing and dynamics in explaining the contribution to musical communication. Repp (1999) found that, when taking into account the aesthetic impact of music performance, timing and dynamics account for only 10–18% of the listener's evaluation of performance, while the most significant feature becomes 'touch'. Repp (1999) further suggested that melody is endowed with a singing quality through touch that audiences resonate to since it invokes a response in their own bodies due to the impact of a mixture of multiple factors (e.g. smoothness of timing and dynamics). This indicates that touch contributes to the inaccessible and aesthetic aspects of musical communication. The communication process may be enriched by simulating the performative actions and movements in the observer's minds, together with audible acoustic cues, inducing an affective or cognitive impact on listeners.

Repp's study has strongly supported the idea that musical communication is not simply encoding and decoding of acoustic/musical cues: for instance, the effect of timbre cannot be reduced to simply a matter of acoustic signals, but also involves how we perceive it visually. Referring back to the touch-tone debate reviewed in Chapter 2, scientifically speaking, the acoustic cues used in timbral communication are merely variations of intensity, timing, and attack noise. So how does the factor of touch (as opposed to timing and dynamics) become such an influential element of aesthetic evaluation? Based on the conceptual blending theory (Antović, 2018; Fauconnier & Turner, 2002), in this thesis I assume that pianists will create a blended space in the production of a timbral effect that is associated with: externalized performing actions, internalized/imagined movement patterns, musical features, and the emotions experienced by the performer. In singing tone for example, similar characteristics of tone production on the piano and in singing allow the pianist to create a mental space of a singing tone, which will include factors such as: the connectedness of articulators (fingers, lips), expressiveness and openness in

musical/vocal expression, and the smoothness of melodic contours in both sounds and the human voice. This is in opposition to the statement that timbral nuances in music performance occur as a realization and externalization of the conceptual space of musicians. Therefore, this study takes the view that piano timbre works as a blended concept in performed sounds – blending music, language, and motion – rather than simply as an expressive acoustic cue.

4.2.4 Timbral communication: emotions and something else?

The communication and expression of emotional intention has attracted the attention of many music-performance researchers, and the utilisation of various timbres has become an effective tool for composers and performers to express distinct emotions in music performance. For this reason, timbral communication has been studied within the scope of emotional communication. For example, Juslin and Timmers (2010) suggested that: a bright timbre is used for expressing happiness; a soft timbre is suitable for expressing tenderness; a dull timbre is good for expressing sadness; a sharp timbre is appropriate for expressing anger. According to Juslin (2000), timbre, together with other acoustic elements (timing, articulation, intensity etc.), are effective 'codes' through which a performer can communicate emotional intention to a listener. Juslin's study suggested the influence of different timbres on the emotional impact of music, which is due to a mixture of timbre and other music parameters (e.g. pitch, articulation). For example: happiness can be expressed by using a fast tempo, moderate dynamics, a dotted rhythmic pattern, airy articulation, and bright timbre. However, less is known about the relationship between timbre and emotion from the viewpoint of the performer.

The association between timbre and emotion has been thoroughly studied in guitar performance. Traube (2004) explained that the use of vibrato creates a rich, warm, sound quality to guitar sounds, and is therefore used by the guitarists to highlight emotional content in the music. Additionally, various guitar timbre descriptors are also associated with emotional expressions; for

instance, a 'bright' timbre expresses joy and solemnity, while a 'warm' timbre reflects feelings of contentment and reflection, or a sunset. Traube's study has considered the association between timbre and emotion in more general terms, by asking participants to give synonyms and antonyms for ten timbre descriptors, and requesting them to describe 'What it sounds like.' In comparison, Holmes' study (2011) on guitar timbre and emotion considered induced emotion in the performer and how they convey emotional content via the sound. For example, timbre-induced emotion in the performer is linked with the intensity of affect, emotional arousal, and sense of self-satisfaction etc. (Holmes, 2011). The later study implied that timbral interpretation and communication might start before the stage of actually communicating to the listener, at a point where the timbre is strongly associated with an emotional context in the performer's inner world.

The research of De Poli and his colleagues has suggested that musical communication is more than just emotional communication, but rather, is closely associated with sensorimotor perceptions (De Poli, Murari, Canazza, Rodà, & Schubert, 2017; Baraldi, De Poli, & Rodà, 2006; De Poli, Rodà, & Vidolin, 1998). De Poli et al., (2018) claimed that sensorimotor expressiveness is the part of musical expressiveness that is not covered by musical and emotional expressiveness, and that it reflects certain cross-modal correspondence features. They further developed a FEI (friction, elasticity, and inertia) metaphor that characterizes the sensorimotor expressiveness in a kinetic-energy two-dimensional space (De Poli, Mion, & Rodà, 2009). Their experimental results indicated that participants are able to describe perceived expressiveness via FEI metaphors (e.g. hard-soft, light-heavy categories), which suggests that there are implications for the FEI metaphor even in non-musical contexts such as dancing and painting, where action and gesture happen in an artistic manner.

To summarise, the communication of timbral intentions is closely associated with emotional expression in music performance. This timbre-emotion association helps to induce

certain emotional reactions in the listeners, and can act as a reward system for the performer, enhancing their sense of satisfaction. However, timbral communication may not always involve emotions, and the element of sensorimotor communication in music has led piano timbre research in a new direction. From the performer's viewpoint, interaction between the performer, the instrument, and the musical sounds, goes beyond the realm of emotional communication. Pianists may be motivated by an emotional intention to vary the tone colours in their performance (i.e. explicit planning), but the production of piano timbre can also be implicit, intuitive, and emergent during piano playing. For listeners, music performances evoke kinaesthetic-energetic responses, and this perception of piano timbre brings the perspective of an onlooker closer to the relationship between gestural control and sound generation. They may experience the dimensions of heaviness-lightness and relaxation-tension in the same way as the performer, when perceiving piano timbre. However, what do listeners perceive in timbral communication? Does sensorimotor communication exist in timbral communication? These are the exploratory questions for my experimental study.

4.2.5 Communication, musical expertise, and possible concerns about experimental design

It is expected that expert musicians will have, not only more advanced physical skills to control and produce piano timbre, but also a richer mental space within which they can 'sketch' global auditory and blended cross-domain experiences, and that they are better able to monitor the subsequent motor controls required. This relates to the issue of the teaching and learning of piano timbre in piano lessons, which will be considered further in the following chapter, which focuses on the impact of musical expertise on musical communication and perception, from the viewpoint of musically trained listeners and non-musically trained listeners.

The hypothesis is that musically trained listeners will perceive timbral intention more accurately than non-musically trained listeners, and that pianist-listeners will be better to perceive

piano timbre than non-pianist listeners. The argument is that these differences result from the ability to recognise and understand a performer's actions, and the extent to which the listener can simulate knowledge of these physical production process in the mind. To make an analogy with football performance, someone who plays football will be more likely to anticipate the ball's movement direction, speed, and trajectory when seeing another football player's kick-off action. Similarly, a pianist listener will be more accurate and find it easier to recognize the other pianist's timbral intention and can therefore generate an auditory expectation (e.g. brightness, harshness, softness) of the performed sound after seeing how the hand is shaped or the body is moving, as compared to a non-pianist listener.

Nevertheless, perceptual differences resulting from musical expertise do not mean that pianists' bodily movements are not meaningful to ordinary listeners. They might still experience strong emotional responses upon observing a musician's performance. For example, Dahl and Friberg (2007) suggested that the listener's ability to perceive the emotional aspects of music is not necessarily reliant on musical training. Increasingly, neuroscientific evidence has also confirmed that non-musicians and even non-human species (e.g. monkeys) (see Gallese, 2001) can share a certain level of emotion and expression in response to music, as a result of mirroring ourselves in the behaviour of others and then recognizing the emotion -- i.e. the existence of empathy. The approach of motion analysis studies on listeners helps us to understand whether or not musical expression can be shared between performers and listeners in a form of shared, music-driven, corporal expression. Leman, Desmet, Styns, Noorden, and Moelants (2009) asked thirty Western listeners (who had never encountered Chinese guqin music) to move in response to recorded guqin music performed by an experienced guqin player, after which, the correlation of movement velocity between both performer and listeners, and between the listeners themselves was analysed. The correlation results confirmed the hypothesis that non-expert listeners share and

decode musical expression in a similar way to the performer even though it is played on an unfamiliar instrument in an unfamiliar music genre.

To return to the topic of timbral communication: non-expert listeners might still perceive sensorimotor expressiveness communicated by piano timbre, for instance the kinesthetic information supplied by tension or relaxation, or the energetic information of tenderness or hardness, and lightness or heaviness. This is deeply rooted in human experience and everyday physical activities enable humans to transfer sensorimotor knowledge into a musical context; however, they might lack the precision and accuracy of an expert pianist. As a starting point, therefore, my research examines timbral communication between student-pianists, and the listeners who participated in the following perceptual experiment were also pianists. The influence of musical training on listeners' perception of timbre will be an area for another research project.

It is also important to note that communication of timbral intention does not require correspondence between the communicator and the perceiver (see a discussion on emotional communication in Juslin & Timmers, 2010). In other words, a pianist might intend to communicate a specific timbral intention in performance but the listener might perceive something different and respond accordingly; alternatively, the listener might also pick up timbral information, when seeing particular moments, which the pianist had not intended to communicate. As an experimental control, my perceptual experiment will therefore be designed in a targeted manner: participants in the listening experiment will be required to focus on communication and the perception of piano timbre, rather than emotions such as liking/disliking the performance or the music. It aims to focus the listeners' attention and awareness specifically on the piano timbre, in order to examine whether a consistency of timbral intention can be achieved between the pianists' performances and listeners' responses.

4.3 Timbre and Communication Mode

When we are watching a live music performance, we can experience enjoyment from both visual and auditory modes of perception. In contrast, when listening to recordings our auditory perception seems to have a greater function while our visual perception seems to be 'disabled'; as listeners, however, we still gain visual stimulation from the 'mind's eye', and may imagine shapes and images as a concurrent experience while perceiving musical sounds. This section begins with a review of studies of audio-visual interaction in music performance, aiming to draw possible implications for the study of audio-visual integration in piano timbre perception. In terms of the visual aspects of music performance, the following sections will be divided into two categories: one focuses on bodily movement as a whole, and considers its impact on musical communication; the other pays specific attention to the impact of music-producing gestures on music perception.

4.3.1 Audio-visual presentation of music performance

Audio-visual integration has been largely studied in speech communication domains such as: speech recognition, image animation, lip synchronization etc. (see a review in Chen & Rao, 1998). For instance, the 'McGurk effect' as demonstrated by McGurk and MacDonald (1976) notes that when mismatched audio and visual stimuli are presented to a person, they might perceive a 'new' sound that does not exist in either sensory modality. For example, seeing a person speaking 'ga' and hearing the sound 'ba', makes a fused perception of the word 'da'. The McGurk effect is also found in musical contexts. For example, Saldaña and Rosenblum (1993) demonstrated the influence of sound-producing actions in guitar performances on the perception of timbre in listeners They also examined the impact of (in)congruent pairings of plucking/bowing sounds in cello performances on listeners' perception of those sounds and found that watching a video performance enabled the listeners to distinguish between plucking and bowing: seeing a bowing

movement led to higher ratings of bowing sounds and seeing a plucking action resulted in a larger response to plucking sounds.

The importance of the visual component of performance in music communication attracted the attention of researchers following Davidson's study of the pianist's bodily movement in communicating musical expressiveness. In Experiment 2 of Davidson's study (1993), a pianist was instructed to play a piece of music in three differently expressive ways (deadpan, projected, and exaggerated), and listeners were asked to rate the expressivity in the condition of seeing only, hearing only, or both seeing and hearing. This study found that once the pianist was playing with a certain degree of expressivity (i.e. in a projected and exaggerated manner), listeners could only differentiate between different degrees when the visual information was present, and not in the audio-only presentation. Interestingly, the ratings of musically naive listeners were even higher in visual-only presentation than with aural stimuli. (Davidson, 1995).

Dahl and Friberg (2007) examined the question of whether performers of different instruments rely on certain parts of the body to communicate expressive intentions, as they move in varying ways while playing their instruments. They tested this assumption by comparing the difference of bodily movements of a percussionist (Experiment 1), and then using performances on various instruments, including a marimba player, a saxophone player, and a bassoon player as experimental stimuli (Experiment 2). Their study aimed to examine whether the specific emotions (happy, sad, angry, fear) expressed by the performer could be recognized by listeners using visual information only. This study confirmed that listeners (not necessarily musically trained) could easily recognize emotions such as happy and sad, and were roughly accurate with anger, but failed to perceive fear. The contribution of their study influenced the design of my experimental stimuli, in a way that I need to consider which elements of visual information are the most effective and relevant when making video recordings of the performers. For example, the movements of the

head may be the most effective part of the body in communicating expression (Davidson, 1994), or sound-producing gestures (e.g. the hands of a marimba player, or the lips of a singer) may be more informative, thus enabling a richer and deeper understanding of the expressive intentions than the body as a whole. I combined two angles in the video recordings: one focused on the movements of the upper body, and the other one focused on sound-producing gestures of the hands (i.e. finger movements). Together, these studies have demonstrated that the visual component of performance is the most influential factor in the perception of expressivity, as listeners failed to perceive expressivity accurately when exposed to sounds only.

The above studies have considered the role of bodily movements from a broad perspective and have examined the communicative functions of various bodily movements (i.e. expressive vs. less expressive). Bodily movement can happen at a very subtle level, and when it relates to sound-producing gestures, the visual information may start to influence perception (i.e. tone duration, interval size etc.). The categorization of bodily movements (e.g. accompanying movements vs. production movements) may explain the visual communication of music performance from a different angle. The listening experiment conducted by Schutz and Lipscomb (2007) suggested that the influence of stroke action in a marimba performance on the listeners' perception of tone duration varied in accordance with the visual information given in the performance (either longer or shorter physical gestures) and the auditory information (longer or shorter notes). This study suggests that physical efforts made by percussionists to overcome the limits of an instrument does have a perceptual effect on the listening experience, as may be the same with a pianist, who may push into the keyboard after the string actually stops vibrating and sounding to create an illusion of a long-lasting note.

4.3.2 Overview of common experimental designs

Changing audio-visual presentation mode. The most common approaches in empirical studies of visual communication in music performance are to: a) instruct the performer to play the same piece with different expressions; b) vary the mode of audio-visual presentation of the recordings and investigate its influence on the listeners' perception of the performance. For example, Thompson et al. (2005, Experiment 1) found that the difference in ratings between a dissonant melody and a neutral melody was larger in the visual condition (where participants could both see and hear the performer) than in the audio-only condition; in other words, the sense of dissonance was enhanced by facial expressions.

The visual presentation of performance not only influences the perception of emotion or of musical structure, but it also affects other aspects of performance such as performance quality and physical attractiveness. Wapnick, Ryan, Lacaille, and Darrow (2004) examined listeners' ratings of six performance elements (tone quality, note accuracy, rhythmic accuracy, expressiveness, adherence to style, and overall impression) in the mode of hearing only and then both seeing and hearing. This study found that the ratings of six performance items were higher in the audio-visual presentation mode than the audio-only presentation. The influence can also be the other way around, that physical attractiveness affects judgments of performance quality. Wapnick, Mazza, and Darrow (2000) conducted a similar study of children's piano performance to Wapnick et al. (2004), where they divided the judges into two groups. Judges in Group A viewed the mute, video-taped performances of child pianists and rated physical attractiveness, dress, and stage manners, while judges in group B rated various performance elements (rhythmic accuracy, dynamic range, phrasing, and overall impression) under the audio-visual condition and the audio-only condition. The results indicated an existence of bias for physical attractiveness, such that child pianists with high physical attractiveness (as rated by group A) received higher ratings of performance quality

scores (as rated by group B). Moreover, the difference in performance scores between the high-attribute children and low-attribute children was significantly greater in video-taped performances. That is to say, video-taped performances exaggerated the rating differences in performance scores of children compared to the audiotaped performances. The authors therefore suggested that teachers should avoid such biases in their teaching as much as they can.

While the above studies imply that auditory information in music communication is less important, Timmers et al.'s study on emotional engagement (2006) presented contrasting results, when comparing the responses of both seeing and hearing performance with hearing only: The listeners were able to make more accurate responses to audio-only performances, whereas a visual mode enhanced the predictability of responses. This study implied that the visual component of music performance communicates embedded expressive intentions; therefore there is no defined 'best mode' in audio-visual presentation of music performance. In other words, the communicative function of musicians will not be 'disabled' in the absence of visual information. At the ICMEM 2015 conference, Fabian (2015) raised the question of how limiting the sound-only condition can be, and suggested that researchers should study sound recordings from a holistic and historical perspective, arguing that sound-only performance can still evoke strong mental images and emotional responses. I would like to argue, however, that the information that is afforded by auditory information is enriched by visual experience of bodily movement, so that listeners are able to perceive motor and sensory information and create mental images of motions and emotions via the knowledge acquired through the action-perception loop in previous musical practice.

Employing matching or mismatching aural and visual stimuli. Another approach employed by researchers is to make congruent or incongruent pairs of audio-video stimuli and examine their impact on listeners' responses. Thompson et al. (2005, Experiment 3) examined the influence of (in)congruent pairings of singers' facial expressions with singing clips on the perception of interval

size, and found that seeing an incongruent pairing (e.g. a small melodic interval accompanied by images of singing a larger interval) resulted in ratings of a larger interval than either of the original pairings. Similarly, when examining the impact of visual information on perceived emotional valence (positive or negative), they found that the rating of a melody in a major key was more positive when accompanied by a happy video, than when accompanied by a sad video. The rating of a minor-key melody also was more positive when accompanied with happy video than with a sad video.

In summary, visual information can sometimes modify listeners' perception of sounds, as confirmed in the study results that employed (in)congruent pairings of performance actions and performance sounds. Hence, one question in the present study is to investigate to what extent the visual aspect of piano performance influences the perception of piano timbre in listeners.

4.3.3 Audio-vision integration

The blending of aural and visual information has great benefits in our everyday lives, for instance in the perception of stimuli localization (Thomas, 1941). According to Spence (2007), 'When presented with two stimuli, one auditory and the other visual, an observer can either perceive them as referring to the same unitary audio-visual event or else as referring to two separate unimodal events' (p. 67). The blending between multisensory modalities (not necessarily aural and visual) in music perception is well documented; for instance the association between pitch and visual height, size, brightness etc. The result of this blending is known as 'cross-modal correspondence' – when stimuli is presented from one sensory modality, it will unintentionally evoke perception from other sensory modalities; this might be caused by several factors including related to statistical regularities in the environmental, neurological structures, or linguistic uses (see a review in Spence, 2011; see also Eitan & Timmers, 2010).

For pianists, the production of piano timbre involves the process of integrating aural (performed tones), visual (bodily movements), and tactile (touch feedback) elements. Watching a piano performance involves the integration of auditory and visual information, including pianist's gestures and the performance environment. If the listener is a pianist, the memory and experience of producing a particular timbre can be activated by listening to the sound outcome or by watching performance actions. This assumption is supported by the 'mirror neurons' theory (Gallese et al.,, 1996), in that similar neural activity occurs when a movement is played and when it is observed. For example, Bangert, Haeusler, and Altenmüller (2001) demonstrated that the auditory area in a pianist's brain is activated when watching a silent video of tapping on the piano and that the motor area is activated when hearing the piano sounds. Therefore, another hypothesis in the present study is that listeners with a pianistic background are able to recognize timbral intentions expressed by the performer via observed finger/bodily movements, even in the absence of auditory information. However, this result might vary, depending on the pianistic skill of the performer.

4.3.4 Intermediate summary

What is the difference between listening to a performance recording and seeing a live performance? Visual information provided by the live performance may make audiences perceive the performance as more expressive compared with listening only. However, this study argues that visual information does not just have an 'add-on' effect, or work simply as a complementary element to auditory information, but rather that visual and auditory information are integrated together, and therefore shape our perception of music performances. This is similar to the process of integration between text and music when we listen to operas or songs (Zbikowski, 2002), as well as the integration of moving images with background music when watching films (Audissino, 2017) – the whole is more than the sum of the parts.

4.4 Timbre and Cross-Modal Correspondence

4.4.1 Cross-modal mapping

The section on timbre descriptors (2.3.3) has indicated that the impression of different timbral qualities is associated with visual perceptions (brightness/darkness) or physical properties (sharpness/ roundness). The relevance of auditory experience to visual experience relates to the notion of cross-modal correspondence (CMC). CMC has been explained as '…the congruency effects between stimuli presented (either physically present, or else merely imagined) in different sensory modalities that result from the 'expected' (i.e. a priori) mapping between those sensory cues.' (Parise and Spence, 2013). Additionally, the CMC experience is not found in the audio-visual dimension only; instead, the associations can be found in kinesthetic, tactile, and even gustatory and olfactory dimensions (see Eitan, 2017 for a review). The following paragraph will illustrate timbre-related CMC experience and its relation to visual shapes (Adeli, Rouat, & Molotchnikoff, 2014), visual texture (Giannakis, 2006), and smells (Crisinel & Spence, 2010; 2012).

The experimental paradigms used to examine the existence of CMC in response to musical sounds include speeded classification and forced-choice. One common format of the speeded classification task is to ask participants' response to one dimension (e.g. auditory stimuli), during which irrelevant information will be presented from another sensory dimension (e.g. visual size or visual height) to test the response time. The difference in the response time reflects the extent to which the presented stimuli and the task-irrelevant stimuli share certain CMC features. Researchers have found strong evidence of associations between visual stimuli (elevation/shape/size) and musical pitch, by using a speeded classification paradigm (Marks, 2004). Another experimental paradigm involves the use of forced-choice tasks to investigate graphic representations of music – in which participants have to choose one answer from a list of options

in response to sound stimuli. By using this research paradigm, researchers have found CMC between musical sounds and visual shapes (e.g. Eitan & Granot, 2006; Athanasopoulos & Antović, 2018). A few, more creative, methods have started to appear alongside the traditional paradigms. This may include, for instance, the utilisation of self-report methods to investigate CMC between musical sounds and imagined motion (Eitan & Granot, 2005c), a real-time drawing method to examine the position and characteristics of drawing in response to music (Küssner & Leech-Wilkinson, 2014), and the employment of visually presented scales to estimate a continuous mapping between pitch and location (Timmers & Li, 2016).

The origin of CMC experience has been fully discussed by Spence (2011) who provided three types of correspondence: structural, statistical, and semantically mediated, among which the first might be innate while the latter two are learned. Structural correspondence may arise from the neural system we use to process sensory information: for instance the loudness/brightness association results from an increase in stimulus intensity causing increased neural firing. Statistical CMC such as the association between pitch and visual size/elevation is learned via interaction experience with regularities of the environment. However semantic CMC such as an association between pitch and elevation (high/low) as well as between pitch and thickness (thick/thin) is learned in the more advanced stages of language development, and has come to be associated wit more than one perceptual continuum (Spence, 2011).

Only in recent years has the embodiment theory been used to explain on the origin of CMC (Montoro, Contreras, Elosúa, & Marmolejo-Ramos, 2015; Eitan & Timmers, 2010). The founding fathers of sound symbolism research, Köhler (1929) and Sapir (1929) found an association between nonsense syllables and physical shape. For example, when the nonsense word ‘Takete’ is matched with a spiky shape and the word ‘Maluma’ is matched with a rounded shape (i.e. the Bouba-Kiki effect), the majority of participants tended to associate a taller round table with the

word ‘mal’ while associating a smaller, round table with the word ‘mil’ (i.e. the mal-mil effect). According to Spence and Deroy (2012), this sound-size association phenomenon can be explained from an embodied perspective. They explained that uttering an ‘ah’ sound requires a larger and more open mouth shape than uttering an ‘i’ sound; this embodied experience also has an impact on our perceptual abilities. Evidence was found in the study of Sweeny, Guzman-Martínez, Ortega, Grabowecky, and Suzuki (2012) that hearing a sound can change our perception of the size and shape of the mouth. Montoro et al., (2015) found a cross-modal association between spoken emotional words and vertical space (up/down) by using a speeding-up paradigm. Interestingly, the knowledge of mapping emotional words onto vertical space is not activated when listening passively (i.e. just listening to the spoken words), but is activated when the task involves cognitive processing (e.g. judging the positive/negative value of the spoken words) before giving responses on a vertical space. Similarly, Timmers and Li’s (2016) study confirmed the embodied nature of cross-modal coupling between musical pitch and horizontal space (left-right) via a series of experiments. They found that pianists’ tendency to perceive higher notes as coming from the right (low to left) was stronger after playing several musical exercises on their instrument (Experiment 3) than when passively listening to notes of varying pitch (Experiments 1 and 2).

4.4.2 Timbre-related CMC experience

Only a few studies have been conducted to directly test CMC with musical timbre. Adeli et al., (2014) compared the timbre-shape association between soft and harsh timbres. They found that a soft timbre (e.g. piano) is strongly associated with round shapes together with blue, green, or lighter grayscales, whereas a harsh timbre (e.g. crashing cymbals) is associated with angular shapes together with red, yellow, or darker grayscales; while timbres that are in between softness and harshness are associated with a mixture of shapes. Interestingly, this study also found audio-visual cross-modal correspondences in response to various timbres produced from a single

instrument. For instance, modified piano sounds with a softer timbre were associated with lighter grayscales; while piano sounds with harsh timbres were associated with darker grayscales. This is consistent with musicians' conceptions of piano timbre, as they tend to describe piano tones metaphorically with tone colours, in the sense that timbral variance refers to monochromatic changes (white-grey-black) rather than chromatic variances (Hamilton, 2012). Additionally, Crisinel and Spencer (2012b) found that different instrumental timbres are associated with different smells, with the piano evoking more pleasant smells compared with brass instruments. When considering the visualization of different sounds via computer science technologies, timbre can be associated with visual textures that vary in terms of sharpness, compactness, and sensory dissonance (Giannakis, 2006).

There are several peculiarities in researching CMC in music contexts. Piano timbre perception works as a blending experience of musical parameters (e.g. a mixture of pitch, tonality, harmonic, rhythmic impression) rather than a sound that solely expresses a binary musical feature (high/low pitch, loud/soft volume, short/long duration, quick/slow tempo). As indicated by Eitan (2017), surprising results might arise from the examination of CMC in musical contexts: for instance a rising melody played with diminuendo expression would banish the association between musical pitch and vertical motion, i.e. the rising pitch is no longer felt with a rising contour (Granot & Eitan, 2011). He suggests that any study of CMC in a musical context needs to consider the fact that a single pair of cross-modal dimensions will not have the same outcome when part of a multiple dimensional context.

4.5 Summary

This chapter started with a review of several typical models of music communication. It aimed to draw attention to the differences of these models in terms of the passive or active role of listeners in constructing musical experience and meaning, and the increasing consideration of the role of

embodiment in musical communication. This study is in line with the embodied and enactive communication model. It is assumed that timbral communication may be not merely information-processing from the composer to the performer, then to the listener via shared codes in musical structure or acoustic information, but, rather, a meaningful interactive event sharing possible sound-gesture affordances, correlations, and connections, that are implied in colourful piano sounds.

Several new insights are summarised from the literature review, which need further investigation in empirical studies. Firstly, in the communication chain (performer-listener) – the interaction and communication between the performer and the instrument has been paid less attention. The reviewed literature demonstrates that performers communicate timbral intentions to listeners but also to themselves, as a result of self-motivation in music performance. This has challenged the unidirectional feature of typical models of musical communication (composer-performer-listener), with new understanding of the performer-instrument communication. Secondly, this chapter has proposed a hypothesis that pianists communicate more than emotions in the production of piano timbre and also that listeners can perceive multidimensionality in piano timbre. There can be a rich multisensory response to timbral communication that may include kinaestic, motoric, tactile, visual, and proprioceptive responses.

This chapter and the previous chapter have been concerned with the perception and production of piano timbre from a first-person point of view and also from that of a second person. Taken together, the perception and production of piano timbre has been largely explored by an embodied perspective in order to investigate the sound-gesture relationship, via the lens of the internal conceptualisation process and the embodiments of that process. The next interesting angle is that of the real-time mutual influence, interaction, and cooperation between two pianists in terms of the intentionality of piano timbre. The partnering of teacher and student is a perfect example to use for the investigation of joint musical practice. The following chapter will address

understanding, comprehension, and the learning and teaching of piano timbre concepts in a more real-time, social, and dynamic context i.e. a one-to-one piano class at university level.

Chapter 5: Teaching and Learning Piano Timbre: Significance, Contents, and Strategies

'*In my work with my pupils, I can say without exaggeration that three-quarters of all work is work on tone*'

-- Heinrich Neuhaus (1998, p.56).

5.1 Introduction

The teaching and learning of 'timbre', 'tone quality', or 'piano tone' is acknowledged as a crucial element in any piano lesson; however the actual teaching and learning process, the strategies used, and the relevance of various motor and mental skills has not been fully revealed and explained. According to previous chapters, the concepts of piano timbre are associated with cross-domain experiences and physiological responses, and are communicated with both sound outcomes and embodiments from multisensory dimensions. This chapter will address how abstract timbral concepts have been taught and learnt in the one-to-one piano tuition context.

This chapter is concerned with the teaching and learning of piano timbre targets in higher education context, with comparisons between UK contexts and Chinese contexts. Additionally, I only focus on the classical piano education context, in which context the one-to-one tuition relationship between the teacher and the student is a distinct form compared to other musical genres such as pop and jazz where classroom teaching or ensemble performance is commonly adopted. The higher education context one-to-one tuition relationship will influence the teaching goals, contents and teacher-student interaction patterns related to the teaching and learning of piano timbre, as will be discussed later.

In relation to the broad study area related to the instrumental learning context, the teaching and learning of piano timbre has been classified as the learning and development of technique (e.g. 1995 Music Advisers National Association (MANA) document, Hallam; 1998). As a result, the

study and understanding of how timbre teaching/learning takes place has been narrowed to a focus on technique and motor skills.

This chapter will demonstrate that the teaching and learning of piano timbre concerns the acquisition of physical motor skills (playing techniques) and also mental skills (planning, mental representation), which can be regarded as lifelong learning targets. Obviously large amount of time in the one-to-one piano tuition and other instrumental teaching will be spent on teaching physical motor skills. These involve the utilisation of different muscles (fingers, arms, bodily coordination, leap trajectory etc.), muscular control relating to tension and relaxation, as well as the ability to understand sensations of weight, force, energy, which are fundamentally important in the teaching and learning of piano tone production. Teachers are also concerned with the pupil's development of cognitive and sensorimotor skills, for instance the identification of proprioceptive feelings and mental presentation skills in timbre production. The use of pedal is another key element in the use of technique to create timbral effect, but this will not be the focus of the present study, as this thesis is more interested in the gestural controls of performers (i.e. fingers, gestures, & bodily movements) to vary the piano timbre. Taken together, the discussions on the playing techniques, the relevance of proprioceptive feelings and mental skills to tone production, and the importance of lifelong learning of piano timbre, aim to give a coherent picture of piano timbre pedagogy.

A good mixture of teaching strategies can help teachers and students to communicate the concepts and intentions related to the production of piano timbre in piano lessons. These may include verbal communication (metaphors, instructions, questions etc.), and non-verbal communication (e.g. modelling, gestures, physical touch). Most of the mentioned teaching strategies will be reviewed in this chapter, with a greater emphasis on the use of action-metaphors in piano lessons. This chapter, therefore, aims to explore the following questions:

- How is timbre referred to in a piano lesson?

- What teaching strategies are commonly used in a music lesson and how are they relevant to the teaching and learning of piano timbre?
- How are sounds, movements, and language linked in the communication of piano timbre?
- How does the teaching and learning of piano timbre differ relate to the student's performance level?

5.2 Piano Teaching in a Higher Education Context

Piano teaching in a higher education context is in the form of one-to-one tuition, in which context, the student is allocated to one specialized tutor at the beginning of the course; this one-to-one teacher-student relationship normally lasts for at least four years. However, in the UK, piano tutors are usually part-time staff with little connection to the university beyond their teaching hours (Gaunt, 2009), whereas piano tutors in Chinese universities normally work full-time and have administrative duties in addition to teaching. Also, the relationship between the Chinese teacher and the student generally begins prior to the university course, and in some cases has existed since the student's time at high school.

Several researchers have explored the characteristics of one-to-one tuition in instrumental study in the context of higher education. Gaunt (2008, 2009, 2011) has highlighted the influence of the intensity of the teacher-student relationship and the power of the teacher over the student's learning outcome. For example, she mentioned that teachers generally have little awareness of the extent of their influence and impact on their own students, but that they clearly remember their past experiences as a student and recognise the impact of their own teachers (Gaunt, 2008). Students were generally positive about this one-to-one relationship and considered it a comfortable learning environment; however as Gaunt (2009) argued, it might because the students were fearful about what might happen if the relationship falters. These studies implied that the one-to-one tuition relationship is not only concerned with the professional development on physical and musical skills, but also a reflection on social interaction pattern for instance the confidence,

autonomy, dependence of the teacher and the student. This thesis assumes that the power and tension of the one-to-one relationship influences how the student behaves in the lesson, and will be reflected in the relative amount of teacher behaviour (instruction, modelling, talking) and student behaviour (playing, talking).

It has been suggested that this teacher-student relationship is something like a master-apprentice model which, over time, develops into a mentor-friend model – in which context the dominant role of teacher is decreased by the increasing contribution and participation from the student, resulting in a stronger feeling of autonomy of the student (Lehmann, Sloboda, & Woody, 2007). In addition, although teaching strategies such as scaffolding methods (see Byrne, 2005 for a review) and dialogic teaching (Alexander, 2008; Meissner, 2017) have been studied to investigate the impact on enhancing students' independent learning, little is known about which type of model is best suited to the teaching and learning of piano timbre.

5.3 The Teaching and Learning of Piano Timbre

5.3.1 Background

Creating colourful piano timbres is a musical skill that concerns for both piano teachers and student. Piano timbre has previously been defined as a subcategory of the area of 'technique' in instrumental teaching and learning. For example, 1995 MANA documents[3] identified the teaching of tone quality solely with the area of technique, and not as an element of the other five study areas: interpretation, aural awareness, composing, communication, and critical awareness. Hallam and her colleagues (1998; 2018) listed a number of distinct musical skills such as: aural, cognitive, technical, musicianship, performance, learning, and also social skills; the development of expressive tone quality is found in the cluster of technical skills. However, the present study argues that the awareness and development of expressive tone quality is not associated with technical skill

[3] Music Advisers National Association

alone, but rather, involves and is mapped onto other skills. For instance: the importance of aural skills in the ability to know how music should sound without having to play it; certain cognitive skills are needed to analyse musical style, and cultural and historical backgrounds; musicianship skills are linked to the sophisticated techniques required to convey musical meaning and expressiveness, which in turn are linked to performance skills and the ability to communicate with an audience; the skill of learning, primarily from the teacher but also the ability to evaluate one's own actions independently.

The topic of timbre, or tone quality has not only been studied in isolation, but with other performance features (e.g. dynamics, articulation) in instrumental teaching observation studies. For example, Goolsby (1997) found that expert teachers spent a greater amount of time on verbal instruction for tone quality (11.8%), expression/phrasing (16.7%), and articulation (21.4%) than novice teachers (1.7%, 0.9%, and 9.8% respectively) and student teachers (1.2%, 2.4%, and 8.5%). The increase in the proportion of time spent on tone quality from student teachers to expert teachers implied that more emphasis was spent on the teaching of tone quality by experienced teachers and that they realized this teaching objective by using more developed teaching strategies.

5.3.2 Playing techniques

Touch types. Touch is one of the most effective tools enabling pianists to create timbral nuance, other than the pedal. There are several types of touch which are classified as: attack type (percussive vs. non-percussive), size of area contact between fingertips and the keyboard (curved vs. straight), duration (legato vs. staccato), rigidity (soft vs. hard) and the utilisation of different bodily parts (finger vs. arm). Some of the knowledge about the relationship of touch and tone quality has been mentioned in Chapter 2 (Section 2.3.2). However, it is necessary to note that the challenge in the piano playing comes from the precise control of which and how each muscle is involved, and sensitivity of different bodily feelings (either from wrist, forearm, or shoulder). For example, Hamilton (2012) identified four categories of touch, namely: finger touch, hand touch,

arm-weight touch, and full-arm touch. Hamilton suggested that finger touch is completed by pulling the finger down until the tendon that is attached to the muscle in the forearm is relaxed and finger/key is back to the original position; hand touch is played by the downward motion of the finger and felt with the interruption and reaction upon the wrist. In contrast, the force in full-arm touch comes from the shoulder but all the joints are linked firmly in this touch. It seems that the key differences in four touches relate to not only the amount of force demanded in the musical piece (finger touch for lightest grade of tone while full-arm touch is used for heavy works), but the physiological and biological feedback in different joints (i.e. inertia, resistance, elasticity, contraction etc.). It is easy for a pupil to decide whether to move the finger or the arm, but it is much harder to feel, monitor, and adjust the sensations which come from different parts of the body, according to my own performance and teaching experience.

Energy, force, and weight. Clearly when different types of touch are applied to the keyboard, the amount of energy and weight exerted by the body becomes significantly different. More interestingly, the notion of energy and weight is not barely a more-or-less issue; instead, playing techniques require a pianist to acquire more advanced skills such as considering the direction, flow, and rotation of energy and weight. For instance, Tobias Matthay suggested that in the arm touch, the arm, finger, and hand act to *convey the weight* upon the key (1908). Pianist will experience the weight and energy transfer vertically in this circumstance. Playing the piano, therefore, requires a wide range of movement – more so than other instruments such as the flute; for instance, sometimes ‘thumb-under’ movements are needed by the pianist to reach the keys when playing ascending or descending scales or arpeggios. In this case, keeping the shoulder and upper arm still, the weight and energy is then transferred horizontally through the wrist and fingers.

The production of piano timbre of a musical note or chord may experience the conveying of weight and energy in a temporal manner. It is common to notice that pianists sometimes make beautiful and elegant arm movement even in the production of very light notes or chords. In such

cases, the arm and shoulder movement is not intended to control the applied force to the keyboard, but to convey the weight fluently to the key, as if there is a 'flow' of energy that transferred from the performer's body to the keyboard and to the string of the piano. It is reasonable to assume that the perception of piano timbre in pianists may be associated with the physical experience of the flowing of weight and energy.

Tension and relaxation. The acquisition of independent finger movement is a key aspect in the development of piano performance technique, during which muscle tension and relaxation becomes important since the muscular contraction of the arm and wrist either enables or prevents the fingers moving independently of the hand. Famous piano pedagogues in the twentieth century such as Otto Ortmann, Heinrich Neuhaus, George Kochevitsky, and Gyorgy Sandor have emphasized the importance of muscular relaxation and contraction often devoting entire chapters in their monographs on piano playing; however, their methods of using relaxation slightly differ from each other.

Neuhaus (1993) favoured complete relaxation in the arm, wrist and shoulder. He suggested that a beautiful piano tone is always accompanied with greatest flexibility but not weakness, and believed that all accuracy is concentrated in the fingertips together with a relaxed arm, where relaxation starts from the back and the shoulder and continues to the fingertips. He made a comparison between the coordination of fingers and arms and a line of soldiers: 'A good tone is complete freedom and relaxation of the arm and wrist from the shoulders to the tips of the fingers which should always be at the ready, like soldiers at the front...the rest--hand, wrist, arm, shoulder, back--that is 'behind the lines' and must be well organized.' (p. 69) Neuhaus's idea of 'good tone' implies that pianists seem to have their own standards for good or satisfactory when evaluating the produced piano timbre; however, this knowledge is subjective and different performers and piano teachers may have different opinions. The subjectivity of piano timbre is examined in my third empirical study – the observational study of piano timbre teaching and learning - where the piano

teachers frequently referred to ideal types of piano timbre that they found satisfying and thought to be good, successful, and wanted (see Chapter 9 section 9.4).

In contrast, Ortmann and Sandor rejected the full relaxation in the arm. Kochevitsky argued that the act of playing the piano consists of motor activities where contraction and relaxation in the muscle constantly interchange (like walking is easier than standing, due to the interchange of muscular relaxation and contraction). Sandor (1981) stated that the free-fall arm drop is not a completely relaxed action; instead, the quality of a tone depends on how the different joints of the arm and fingers are fixed: if the joints are too loose, the produced sound will be shallow; if the joints are too rigid, the sound will be very harsh.

To conclude, the production of piano timbre requires the correct utilisation, combination, and interchange of muscular relaxation and tension; even in the full-relaxation approach mentioned by Kochevitsky (1967), Neuhaus (1993), and Hamilton (2012), there is still some degree of tension in the finger joints. The challenge in piano teaching and learning is not just about understanding the exertion of a performance action from particular joints and muscles; but, rather, lies in to the extent to which a pupil can learn to control and monitor relaxation, and also the ability to be aware of, and distinguish between, tension and relaxation.

The aim of reviewing the piano playing techniques is not to establish a systematic method for teaching tension, relaxation, weight, energy etc. in piano playing, or to offer a guidance of playing techniques. Instead, this section aims to make a connection between the exertion of bodily movement and the pianist's own ability to understand and feel these movements, and their relevance to sensations of piano timbre, such as verbal descriptors. It is also interesting to examine how pianists themselves describe their playing techniques and to what extent this is linked to description of piano timbre: for instance as Sandor mentioned, harsh tone a result of rigid movements while shallow tone is a result of weak joints. This is further investigated through a qualitative approach in the present interview study and the teaching observation study.

5.3.3 Proprioceptive sensations

Piano playing does not involve solely physical movements; the pianist gets abundant information through interacting with the instrument and also from his/her own bodily feelings. The information generated from the interaction with the external environment is known as *exteroception*, while the physiological response generated within one's own body is called *interoception* – which refers to the sensation of internal bodily changes and 'the ability to detect subtle changes in bodily system, including muscles, skin, joints, and viscera' (p. 1835, Dunn et al., 2010). According to Schneck and Berger (2005), the human body consists of various sense organs which enable us to take information from both the external environment and also from our own body; and that proprioception is a specific type of interoception (proprietary meaning 'one's own'). 'Proprioception gathers information about pressure and temperature from the skin receptors, the relative state of the body segments, balance and posture, skin-stretch, fatigue, and effort as well as information from internal organs.' (Eilan et al., 1995, p. 12)

The need for a pupil to have a sense of interoception in the production of piano tone, has been clearly indicated in the views of several piano pedagogues. In 1927, Thomas Fielden, a professor of piano at the Royal College of Music, emphasized the idea of sensing muscular contraction in addition to his other key emphasis on perfect timing, in successful tone production. He suggested that a pupil who did not sense muscular contraction when playing, should place a hand lightly on a table and then press with enough tension to experience the feeling of muscular contraction. At around the same time, the pianist, Levinskaya, also suggested that it was imperative for pianists to realize, and be aware of, which lever (i.e. joint) they intended to use and then to create a firm ground for operating this action by fixing some joints with muscular contraction (1930). In this way, bodily awareness – a sense of proprioception – helps the pianist to monitor and improve their playing action. A pianist should not only know how to move their body (e.g. have awareness of touch types and joint coordination) and use playing techniques, but they should

also have bodily awareness of proprioception feelings – i.e. to know exactly which part is fixed while other parts are loose or relaxed, and to have a feeling of how much weight is involved in different parts of the body.

In addition to the benefit of improving playing technique, proprioceptive information also functions as proof of consciousness while undertaking musical activities. For the purpose of this study, I will limit this notion of consciousness to a sense of bodily awareness and mental focus when learning tone production – as used and explained by Godøy (2011): 'We may also encounter the expression of conscious used in the sense of being aware of something, and although expression awareness is also entangled in a complex web of significations, it does in my opinion have the advantage of more narrowly designating what I would call a focus of mental content.' (p. 231).

Piano teachers often tell their pupils to 'play with your mind, not just your fingers!' I think that this state of playing consciously with the involvement of both physical movement and mental awareness, can be facilitated and achieved by proprioceptive information. By feeling bodily sensations, the student can integrate their mind (intentions) with their body and create a concentrated mental state of 'playing with thinking'. As claimed by Acitores (2011), proprioception theory can be seen as an embodied account of musical consciousness, in which the body works as the basis for consciousness. More specifically, she suggested that proprioception has two aspects: the feeling of the body, i.e. proprioception, affords both 'bodiliness' information (i.e. bodily feeling like the sensory input from one's explorations) and 'grabbiness' information (i.e. certain features in the music which are more likely to attract our attention). The teaching of piano tone production, therefore, is the process of sharing and knowing proprioceptive information with the student, more specifically with regard to the sensory experience associated with particular performance actions. Evidence that this is happening can be found in the verbal input of the teacher in comments such as: 'It's too tense.' or 'Too much weight.' Although the teacher is not experiencing any tension or weight themselves at that moment, they can mirror the sensory

experience they perceive from hearing the sound quality produced by the pupil. This is consistent with the 'mirror neuron' theory, that to understand and perceive a sound is to internally simulate the movement related to the sound (Leman & Godøy, 2010; Anumanchipali, Chartier, & Chang, 2019).

5.3.4 Mental skills

In addition to the teaching of playing technique, piano teachers aim to develop the student's cognitive skills in order for them to produce a better piano timbre. This section will focus on the construction of the mental representation of prepared/performed piano tones. The idea of being aware of the mental presentation of performance outcomes has been further discussed by Lehmann and Ericsson (1997) in the context of musical education. They proposed that an expert musician should put the desired (goal) performance (how the music should sound) at the forefront of the mental process of music performance; this is then followed by mental process involved in producing the sound (the knowledge/ability to implement the goal), and then mental evaluation while performing (monitoring one's own performance). This is consistent with the opinions of several piano pedagogues, (Friedberg, 2002; Kochevitsky, 1967), who advocate letting the mind guide the body in piano playing. What needs to be clarified, however, is that although the mind leads the production process, it is not separated from the physical movement process; the mental process will consistently receive multisensory feedbacks and modify future performance actions.

Another way seeing the integration of mind, body, and music in timbre production is to view it as a type of decision-making and mental planning; the pianist needs to choose an appropriate technique for a particular timbral effect when practising and in the concert, which could be either spontaneous (an automatic decision) or a result of explicit planning (a deliberate decision). These two types of decision-making in music performance have been explained by Bangert, Schubert, and Fabian (2014) using a spiral model, showing the growing of musical expertise. The deliberate decision-making process is slow and involves conscious awareness and

explicit planning, whereas the intuitive or automatic decision-making process is quick and effortless, being based on feelings and senses. They found that expert musicians were much quicker at switching between these two types of decision-making in music performance, and that they found it easier to access either decision-making type – eventually leading to flowing, continuous experiences achieved by rapidly balancing the tensions between the conscious and unconscious mind.

5.3.5 Lifelong learning

The learning of piano tone production is a lifelong learning process, and motor skills take years of practice to develop; sensory-motor ability as well as the cognitive/emotional skills related to the timbre production are acquired and developed slowly, until a pianist is equipped with a set of tools containing sophisticated techniques, aural awareness, expressive intentions, conceptions of timbre etc. Therefore, it is reasonable to assume that the amount of teaching and learning of piano timbre in each piano lesson will vary according to the student's performance levels, as well as the teaching strategy, in terms of the percentage of demonstration, verbal instruction, and the student's self-practice. The aspect of lifelong learning and training in the area of piano timbre will be explored in the follow-up interview study with the pianists and also the teacher-student pairs.

5.4 Cross-cultural Differences

Originally, the piano was a western instrument which was then imported to China and developed at the beginning of the twentieth century (阎, 2018). Chinese compositions for piano often use a combination of Chinese and Western musical languages (in terms of scale, mode, harmony, polyphony) to realize a so-called Sinicization of the sound structure (阎, 2018; 张, 2018). Several well-known pieces of Chinese piano music are adapted from Chinese traditional music and recreated with a new polyphonic structure or musical form (cf. 代, 1999). For example, *er quan ying yue* (the moon over a fountain) is adapted from an *erhu* solo work (a stringed instrument);

bai niao chao feng (song of the phoenix) is recreated based on *Suona* music (a woodwind instrument), and *mei hua san nong* (Plum-blossom in three movements) is rearranged from *xiao* music (a Chinese flute). As a result, the timbre of the instruments being imitated and the images/atmosphere depicted in the title may influence the intended 'sound' that pianists want to express in the interpretation of these works.

Cross-cultural differences in the understanding of piano timbre may be found in distinct playing techniques borrowed from Chinese traditional instruments and the metaphorical language used to communicate piano timbre. As mentioned earlier, several playing techniques are borrowed from the playing of Chinese traditional instruments for imitative purposes to interpret composers' intentions. The Chinese piano pedagogue, Xiaosheng Zhao (赵，2007), has given a dedicated explanation of twenty types of piano touch using metaphorical descriptions, which are translated into English in Table 5.1 below. This concept of creating orchestral sounds on the piano is consistent with western piano playing traditions in which context the piano imitates other instruments such as voice, violin, percussive instruments etc.

In general, these action-metaphors combine the multiple dimensions of relaxation and tension, size of fingertip, energy, weight, and embody them in a more straightforward and vivid way. Although some of the lightest grade of action-metaphor such as 'touch', 'feel', and 'wipe' are similar in the amount of weight, they differ in either the movement direction (i.e. '*feel*' is from inside to outside) or duration ('*wipe*' is a quick, short movement). Several action-metaphors are not movement descriptors but, rather, a hand shape and gesture, for example 'calculate' is described as squeezing the first, second, and third fingers together when counting, while 'fantasy' refers to the atmosphere and feeling of drawing the fingers quickly away from the keyboard. These action types are called metaphors because they somehow represent a category of physical movements that are not originally from the sound-producing actions in the piano playing; but rather borrowed from everyday physical experience (e.g. wipe, stab, dig etc.) or induce higher

cognitive functions (e.g. imaginations, atmosphere) related to that movements. This approach is not only famous in the context of Chinese piano pedagogy; The teaching of fingering and ideology to play Chinese *qin* uses the same verbal instruction approach, which have been studied by the western scholar Van Gulik (1969), who suggests that this approach is significant, and has potential to influence western music pedagogy.

Table 5.1. Action-metaphors mentioned by 赵 (2007) (My translation from Chinese).

Action type	Chinese/Pinyin	Description of playing technique
Touch	抚 fǔ	Slightly touch the keyboard and play the 'Li tone', producing an extremely soft and hazy sound
Feel	摸 mō	Feel the keyboard from inside to outside
Push	推 tuī	Use fingers to push horizontally, producing a mellow, deep and soft sound
Pull	拉 lā	Gently pull fingers from the inner side of the keyboard to outside
Pick	挑 tiǎo	Erect fingertips and pick up quickly, producing a transparent, clear, resonant and short sound
Flip	弹 tán	Use fingertips to 'flip' forward like flipping strings and produce a plucking sound
Press	按 àn	Use fingers to press the keyboard tightly to increase resonance
Rub	揉 roú	Gently rub the key like rubbing strings after making sound to produce the 'Vibrato' effect
Dig	抠 koū	'Dig' and 'Find' the sound from the depths of the key to improve the explosive force
Stab	刺 cì	Concentrate all the forces of the whole art and use fingertips to 'stab' into the keyboard, producing a concentrating and resonating sound
Click	点 diǎn	Relax fingertips and tap fingertips on the keyboard slightly, producing a light and elegant sound
Lick	舔 tiǎn	Use fingertips to 'lick' the keys like a tongue, producing a function sound
Wipe	抹 mǒ	Use fingers to slightly 'wipe' the keys, producing a string of sounds
Fantasy	幻 huàn	Draw fingertips from the keys, producing a highly concentrated sound
Carve	剔 tì	Use fingertips to play sounds by the keys, and such sounds are more looser than the sounds made by 'draw'

Scrap	刮 guā	Use a move to 'scrap' a string of sounds, which is more like the sound of Zheng instrument
Hum	吟 yǐn	Use the flat end of fingers to rotate in a circle and bring out a function sound, producing the effect of a musical instrument or humming
Tremolo	轮 lún	Use tremolo to play and imitate the tone doubling of Pipa or Yuqin, and make the sounds be of varying speeds, thickness, and strengths etc, without leaving any trace
*Calculate	算 suàn	Squeeze finger 1, 2 and 3 tightly, and touch the keys fast and intensively to produce the 'Bang' sound
Inject	注 zhù	Stab from top to bottom to make a sharper sound than that of 'stab'

Another potential cross-cultural difference in the teaching and learning of piano timbre may be found in the social interaction between teacher and student. Benson and Fung (2005) observed that at pre-college level Chinese teachers modelled more and talked less during piano lessons, than American piano teachers, and employed a greater variety of modelling devices (including singing and gesturing). Additionally, their study indicated that the Chinese and American students acted differently in their piano lessons, with a greater percentage of student performance in Chinese lessons, while there was more dialogue and verbal response in American lessons. In an earlier study, Davidson (1989) explored cultural differences in private instrumental lessons between the UK and China, and found that Chinese music teaching focused more on emotional expression of the music, whilst western music teaching paid more attention to the structure of music and performance techniques. These studies imply that piano teaching in China might be different to some extent from western teaching, with regards to the utilisation of different teaching strategies and teacher-student interaction patterns.

5.5 Action-Metaphors in Piano Lessons

In the publications of piano playing techniques (e.g. Levinskaya, 1930; Lhévinne, 1972; Neuhaus, 1993), it is very common to recognize that the description of bodily movements are based on percussive types (soft or hard, smooth or detached), or the utilisation of various parts of the body

(finger, wrist, or arm). These criteria have provided a systematic guideline on playing techniques related to the production of piano timbre. However, music instructors often use metaphors or analogies of everyday physical movements to persuade their students to use the right technique to play the piano. Metaphors, or figurative language, have proven to be more effective and impressive to the students compared to the literal description of playing techniques (Barten, 1998; Schippers, 2006). For example, displeased with the lack of motoric control in the production of a light timbre, a piano teacher instructed her beginner-student by using the metaphor of 'imagining the keys are very hot and you are afraid of your fingers being burned '—this metaphor made a remarkably audible evidence in the student's performance (personal observation, autumn 2019).

Additionally, staccato touch represents a large category of playing technique, but it has subcategories when it implies either finger-staccato, wrist-staccato, or arm staccato. My impression of a wrist-staccato touch came alive in my personal experience, when my teacher used the action-metaphor of 'pulling' and explained that the fingers and whole hand are together quickly pulling something from the keyboard by using the wrist as a spring that is plastic and bouncy. The type of description is much easier for me to understand compared the literal explanation provided by the well-known Russian piano pedagogue Leschetizky (2005), who explained that wrist-staccato is a type of touch that 'the finger stands 'prepared' (placed in contact with its key), and after giving a quick stroke down, not only the finger but the whole hand is jerked upward from the wrist, dropping quickly back again, in so doing 'preparing' the next finger.' (p. 13)

This chapter is not concerned with every type of metaphor, but the type of metaphor that closely related to physical movements. I will consistently use the term 'action-metaphor' in this chapter and in my thesis, to refer to the type of metaphor that conveys both motional features but also affective qualities and aesthetic intentions. Relevant literature is reviewed below.

Barten (1998) highlighted the importance of motor-affective metaphors in the verbal instructions used by teachers to help their students understand and produce musical expressiveness.

He argued that motor-affective metaphors are characterised by several features: they either (1) refer to a specific type of movement such as lurching, running, walking, jumping; (2) indicate the speed, velocity, and relevant kinaesthetic experience that is associated with the movement, for instance gaining momentum gradually, or being too heavy or tense; (3) refer to specific actions such as sting, fight, push, click on, hold back etc. (4) non-human movement, for example 'Don't start off like horses out of a starting gate – don't jump it.' (p. 93). In the examples provided by Barten, motion and emotion are closely linked in motor-affective metaphors, in that people can induce an affective state by hearing certain motion metaphors. For example, the metaphor of the music sounds like 'jaunty' means both a happy-quality in the rhythmic pattern and a jaunty movement feature, while a lurching implies both a lack of motoric control and a sort of jerky movement. Barten claimed that motional-affective metaphors enable students to go beyond the musical score and play the music with an integrative function.

In the context of piano timbre production, Barten's research implied that the use of action-metaphors not only helps students to master basic technical instructions, but also to understand more abstract and intangible expressive and emotional qualities related to that motional quality. For example, the metaphor of 'dragonfly touches the water in his flight' implies a combination of a lightness of motional feature in the touch quality with a calm- and peace –related scenery and atmosphere that depicted by such verbal expression. Similary, Schippers (2006) explained the extent to which the action-metaphor of fingering on the Chinese *qin* (an ancient Chinese zither) expresses an aesthetic intention: 'The fingers of the musicians evoke the movement of waves. Lightly, they float over the strings, with elegant and precise strokes'. (p. 211)

Verbal instruction when teaching playing techniques in a piano lesson context is an interesting topic in terms of the way in which the teacher describes their intention using the complementary method of modelling. The use of action-metaphor in the teaching and learning of piano tone production has not been systematically studied. The function, percentage of use, as well

as strengths and weaknesses of action-metaphors needs to be investigated, and the third empirical study in this thesis – the teaching observation study – will examine this area.

5.6 Teaching Strategy

5.6.1 Modelling

Modelling is widely used in instrumental teaching and is an aural presentation, either by the teacher demonstrating the music, or via an audio/video-taped performance, to the student (Bonastre & Timmers, 2019). In the context of classroom-based instrumental teaching, the strength of modelling has been emphasized by many researchers (Dickey, 1991; Sang, 1987; Hallam, 1998). Modelling strategies such as melodic echoes or rhythmic movements to music helps the student to achieve greater ear-to-hand and kinaesthetic response skills (Dickey; 1991). Teachers' modelling improves instructional effectiveness in the classroom and students' performance accuracy; teachers with stronger modelling skills are more likely to produce students with better performance skills compared to teachers who use verbal instruction only (Sang, 1987). When considering instrumental teaching in the curriculum, music teachers' modelling creates an internal representation of the aural image of the music in young students (Hallam, 1998). It is interesting to point out that the studies reviewed above have focused on classroom situations. As Sang (1987) explained, the instruments that require one-to-one supervision were excluded from the study design due to the single teacher-student influence. Indeed, the factor of one-to-one tuition in instrumental teaching and learning may influence the conceptions and perceptions of modelling between teachers and students, as will be reviewed below.

When considering the use of a modelling approach in the context of a one-to-one based private music lesson, the limitations and weaknesses of modelling has been pointed out by several researchers. For example, Woody's (2000) study results, based on questionnaire, reported that only 39% of forty-six undergraduate music students indicated that modelling was utilised most often, while 61% of them indicated that they had been mostly taught verbally in their previous private

music lessons. Additionally, Laukka (2004) reported a preference for verbal-based instruction over a modelling approach in the music conservatoires of UK and Sweden, and mentioned the view that aural modelling may result in 'mere imitation'. Burwell (2005) has highlighted the importance of developing the student's individual style at university level, and of the weakness of modelling in limiting the student's freedom of interpretation as well as their musical thinking and concept development. Similar findings were found in empirical studies of private piano lessons where the teacher spent more time talking than on aural modelling (Speer, 1994; Lostka, 1984).

There are other issues about modelling in private music lessons, such as the student's age, cultural background, and the wider context. Bonastre and Timmers (2019) found that the age of the students was a significant factor that influenced the teachers' views of modelling when teaching musical expressiveness; that modelling was considered as a more appropriate strategy when teaching younger children but that it became the most unhelpful model for adults, as seen in the responses of two samples (UK and Spanish HE music students). With regard to nationality, their study also indicated that UK students rated modelling more positively than Spanish students – who were more positive about the use of metaphors and emotions. Meissner's research (2017) on teaching young children musical expressiveness revealed that modelling was considered to be an effective teaching strategy to teach young students, but the teachers also employed enquiries and improvisation to let the students 'own their performances' and develop their own interpretations.

The difference of the proportion of modelling and talking between classroom lessons and private lessons has reflected that one-to-one based teaching and learning situations place more emphasis on the inner teacher-student interaction and student's independent learning skills, unlike classroom teaching which is more results-driven (e.g. improved performance accuracy, technical fluency). Additionally, the difference between the teaching and learning of piano timbre and other performance targets (e.g. technique, emotional expression, dynamic variance etc.) needs to be

considered in weighing the value of modelling. Dickey (1992) has argued that modelling is the most effective approach in teaching pupils the concept of timbre; that they may fail to discriminate between different timbres by just being told of 'rich', 'bright', or 'thin' sounds, and that their motoric skills cannot be improved just by discussing the tempo and metre. I partly agree with this opinion, that modelling is the final demonstration and representation of a mental concept; however, I would argue that the function of language has a greater effect than Dicky has suggested -- see the section below.

5.6.2 Talking

Apart from modelling, the talking that happens in a class lesson plays an important role in achieving a shared understanding between teachers and students. The current section will look at the power of talk in the classroom context. Two theoretical concepts will be introduced, namely dialogic teaching, and metaphorical/literal descriptions. These are not simply teaching methods; the concepts deal with the relationship between languages, cognition, thinking, and learning (Alexander, 2010).

Dialogic teaching. Alexander (2010) described the approach of dialogic teaching as: 'harnessing the power of talk to stimulate and extend pupils' thinking and advance their learning and understanding. It helps the teacher to diagnose pupil's needs more precisely, to frame their learning tasks and assess their progress.' (p. 1). As mentioned by Alexander (2010, 2018), dialogic teaching not only aims to enhance students' communication skills in the class by the power of talk, but that it also influences the way that teachers and students conceive of knowledge. Dialogic teaching has also been related to the notion of scaffolding, in terms of constructing shared conceptions (Alexander, 2000), and scaffolding pupils' active participation (Muhonen, Rasku-Puttonen, Pakarinen, Poikkeus, & Lerkkanen, 2016). In the musical context, Meissner (2017) has demonstrated the role of dialogic teaching in enhancing young musicians' musical expressiveness, by using open-ended enquires in the discussion of musical character.

Metaphorical/literal description. Clearly the sonic outcomes of timbral concepts can be partly demonstrated by modelling, but the literal description of musical results (e.g. 'It's getting louder here') can also help the student to make sense of the concurrent changes with other performance parameters resulting from a timbral effect, hence enabling them to generate an explicit performance plan; also, metaphorical description of timbre can also convey a teacher's mental images and associated feelings. Aural modelling accompanied with verbal communication (e.g. 'Listen to my performance, and notice how I do the crescendo in the first measure.') helps the student to identify performance features and informs their imitation (Woody, 1999).

Burwell (2006) studied verbal instruction in both instrumental teaching and vocal teaching and compared the use of two types of vocabularies (literal and metaphorical) in those two cases. It was found that literal vocabulary was used to address issues such as pitch, rhythm, volume and timbre, and to describe formal aspects of music (keys, themes, and textures) or the operation of musical instruments (e.g. the physical properties); in contrast, metaphorical vocabulary occurred in experiential, emotional, and figurative language contexts. The study found that the use of metaphorical language occurred more frequently in vocal teaching than in instrumental teaching irrespective of whether the teaching related to technical issues or interpretative issues.

Woody's (2000) questionnaire study reported that most undergraduate music students preferred communication using feeling-oriented descriptions rather musically or technically-oriented instructions when learning music expressiveness. Colprit (2000) found that music teachers frequently talked about teaching targets in terms of musical results (such as achieving a certain tone) rather than physical behaviour (e.g. the motion of the bow) suggesting that teachers tended to see performance goals as the achievement of a musical or acoustic effect rather than as the mastery of a physical gesture.

To conclude this section, this thesis will examine the role of talking in the construction of shared understanding and conceptions of piano timbre between teachers and students. Two types

of verbal behaviours will be investigated: the use of dialogic teaching, and types of verbal descriptors. For example, a teaching observation study was conducted to investigate whether timbre targets were easier to communicate using descriptions of the sonic results of louder or shorter (i.e. musical descriptors), physical movements like 'to push' (i.e. physical descriptors), or emotions and feelings (i.e. cognitive descriptors). It also looked at particular examples where dialogic teaching occurred. The central idea related to dialogic teaching and verbal descriptors is the use of communication skills in the teaching and learning of timbre targets, but this thesis aims to investigate more than that. In relation to the embodied account on piano timbre, language plays a role in activating an embodied simulation and is grounded in sensorimotor experiences. Therefore, this thesis will explore the importance of both language and modelling, and the strength of the combination of the two – how language and modelling integrate together in the sense-making process of teaching and learning of piano timbre.

5.6.3 Non-verbal teaching strategies

Piano teachers do not convey and demonstrate ideas related to piano timbre by using sounds or words only. Besides modelling and verbal instruction, non-verbal communication between the teacher and the student, involving physical contact, co-verbal and co-musical gestures, also contribute to the student's understanding of music.

Zorzal and Lorenzo (2019) highlighted the importance of physical contact in guitar teaching, and suggested that physical contact works as a platform from which the teaching of the essential haptic contact required to play a musical instrument can take place, and that it is also employed to meet students' proprioceptive needs. Their research found that physical contact is a crucial element in the teaching of body posture, muscle relaxation, and the use of fingernails in guitar performance, regardless of the student's performance level. However, only with lower performance-level students was there a strong correlation between physical contact and progress. Similar findings can be found in Simones, Schroeder, and Rodger's (2015) research on physical

contact in piano lessons: they argued that touch is a channel through which to communicate emotion such as love, sympathy, or gratitude between teacher and pupil, and that touch also works as a platform for the learning of the haptic contact required to play the piano.

In the same way that we use gestures to clarify and convey our intention when we speak, instrumental teachers also use gestures, together with words; in which context, the integration of gesture, music, and speech creates a unified system in the teacher's conceptual world. In relation to piano timbre, sound-production intentions of the teacher are reflected as mimicking gestures in their teaching behaviour (Simones et al., 2015), which refers to '…instances where teachers appeared to mimic a certain mental image of a gesture that they considered appropriate to perform a particular musical sound-producing action while expecting the student to imitate the gesture shown'. (p. 109). These are different from other types of gestures (i.e. conducting gestures, co-verbal beats, deictic etc.) that are concerned with clarifying musical structure or conveying an explicit instruction. Mimicking gestures are strongly associated with sound-production actions and movements and the mental movement imagery of the teacher, which is of great significance the study of the teaching and learning of piano timbre. In the absence of any modelling or verbal instruction from the teacher, this type of mimicking gesture appears to be an important method of facilitating students' understanding of abstract timbral concepts.

5.7 A Methodological Concern

The content and structure of an instrumental lesson is dynamic and flexible, but the moments when the teacher and student set the improvement of piano timbre as their performance goals are identifiable. The following sections will introduce the methods that scholars usually use to analyse video-taped musical lessons—performance goals can be studied in a quantitative and systematic manner.

Lehmann and Ericsson (1997) have explained the concept of performance goals and their relevance for mental representations or images in the musical practice of mature musicians. Their research suggests the possible implication for the music education situation in terms of how to match performance goals to distinct levels of students: 'Music educators should carefully determine the ultimate performance goal for each student and design an educational plan to teach the mental representations that will be necessary to reach that goal.' (p. 53). In other words, the performance goal might be pre-determined by an effective teacher; but the process of the achievement of a particular performance goal might be characterized for individuals depending on the teacher, student and their interactions.

Several scholars have systematically examined performance goals in the context of instrumental teaching using more quantitative methods. Duke (1994) introduced the notion of 'rehearsal frame', referring to the segments where the teacher and student accomplish an identified instructional goal. A practical aspect of identifying a rehearsal frame relates to the starting/ending points of the performance instruction. Colprit (2000) applied this technique in an analysis of the behaviour of string-instrument teachers, by defining the starting point as when the teacher identifies somewhere in the performance that needs to be positively changed/improved, and the end point as the moment when the target is achieved or changed to a new goal. Similarly, Massie-Laberge (2013) proposed the idea of a 'message unit' in the quantitative analysis of time allocation regarding the teaching and learning of music expressiveness, and investigated the teaching/learning activities that included elements of teacher-student interaction such as talking, modelling, feedback etc.

This thesis used a similar approach in the design of the third empirical study—teaching observation study, but specifically examined the segments of the lesson where the performance goal was identified as being related to the improvement of timbre. These segments may contain

difference types of teacher-student interaction pattern, for instance teacher-student conversation, teacher-modelling, student-practising and playing, as well as teacher-dominated talking accompanied by student's playing. The identifiable feature in the students' behaviour may not be the amount of talking, but, rather, the amount of time devoted to playing is an important behaviour. This study also considers segments that are interrupted by other performance goals (e.g. note correcting, fingering etc.) but which are still considered relevant to timbre at an integrated level. I will cut off the time/text that works on other performance goals from the interrupted timbre event. For brevity, the design of the teaching observation study and details of data analysis will be introduced in Chapter 6 (Section 6.4).

5.8 Summary

This chapter discussed the significance of piano timbre targets in the context of piano education: that the teaching and learning of piano timbre relates to not only the development of physical techniques, but also the training on students' aural skills, cognitive skills, and musicality skills such as expression and interpretation. Additionally, this chapter summarised the characteristics of piano lessons in the higher education context and compared it with classroom teaching. It is assumed that the tension, the connection, and the mutual influence between the teacher and the student built in the context of private piano lessons may differ with classroom teaching, and culture may play an important role. The amount of time spent on talking and playing by the teacher and the student in one piano lesson may reflect these differences in a quantitative manner. The teaching observation study in this thesis will investigate the time allocation of teacher and student activities (e.g. teaching talking, modelling, student talking, practising).

Playing techniques related to the production of piano timbre were explored from aspects including touch type, tension and relaxation, weight, force, and energy. This chapter highlighted the importance of proprioceptive feelings in the production of piano timbre, and revealed the fact of the ignorance of considering this in previous studies of piano performance. The teaching and

learning of weight, energy, force, relaxation/tension, and proprioceptive feeling in the piano playing helps to integrate the mind with the body; however, proprioception closes the feedforward and feedback loop by bringing awareness into bodily sensations and mental content, which in turn refines future actions and utilisation of weight, energy etc. The development of the skills mentioned above takes years of training. The teaching and learning of piano timbre should be regarded as a lifelong learning process. Taken together, this chapter emphasized the idea that the physical movements, bodily sensations, proprioceptive feelings help to connect the body and the mind in music performance. The teaching of these aspects in piano lessons creates a shared platform between the teacher and student to conceptualise and experience piano timbre.

This chapter draws attention to the utilisation of action-metaphor. Action-metaphors can help the teachers to convey the mental movement images related to the production of piano timbre to their students, which works as a cross-modal mapping experience that guides and facilitates the physical production process. The teaching observation study will explore the presence and utilisation of action-metaphors, aiming to understand the relationship between sound, body, and language in piano lessons.

Chapter 6: Methodology

6.1 Overview

Timbre has been studied extensively using a linguistic approach, including on instruments including the saxophone (Nykänen & Johansson, 2003), pipe organ (Disley & Howard, 2003 & 2004), violin (Stepánek, 2006). Participants can either describe the perceived timbral qualities via free verbalizations or choose from a list of descriptors. One of the most common aims of verbalization studies of timbre is to find out the most representative descriptors and the distinct semantic clusters that people use to categorize different sounds, on the basis of usage frequencies and familiarity ratings. These linguistic methods can further integrate with acoustic methods to investigate the spectral correlates of timbre descriptors; selected timbre descriptors can be applied to the selection of labels of rating scales in timbre perception-related experiments. The majority of linguistic approaches to the study of piano timbre remain at a macro-level, which considers the timbral differences produced from different pianos. Increasingly, however, studies have paid attention to the timbral nuances produced from a single piano, (e.g. Bellemere & Traube, 2005; Bernays, 2013; Kojucharov & Rodà, 2015), and have taken the aspect of performer-controlled timbre into consideration.

The beginning of this chapter will explain the reasons for objecting to the linguistic and acoustical approaches to the study of piano timbre, and the reasons and strategies for adopting a phenomenological approach. The following sections will introduce the information about the three empirical studies regarding research design, participants, materials, procedure, and data analysis.

6.1.1 Phenomenological approaches in timbre perception studies

Timbre is not only a physical property of the sound, it is also an effective device for performers to create variety in their performances. Experiences, motivations, explanations in relation to the utilisation and perception of timbral nuances have to be explored via more qualitative methodology.

A phenomenological approach has been adopted in timbre research, as shown in the literature reviewed below. Holmes and Holmes (2012) explained the benefits of employing a phenomenological approach in the study of piano timbre. They claimed that this approach focuses on meaning rather than explanation and that it can be an effective tool to gain insights into non-quantifiable elements of performance: 'Phenomenological analysis and interpretation can reveal an idiographic relationship between the subjective conscious awareness and the cognitive landscape of the individual.' (ibid, p. 74).

Nykänen and Johansson's (2003) study of saxophone timbre employed an interview strategy which examined the perception of saxophone timbre from an individual level. Participants in the interview were asked to describe sounds and to comment on their performance practice on different saxophones. Although the central aim of this study is to explore the coupling between the physical property of the sound and the timbre descriptors, one of the valuable insights from this study is in the research design – where musicians could talk about and demonstrate their control over timbre during the interview; the study is not purely concerned with psychoacoustic issues, but how they are combined with phenomenological views.

Bellemere and Traube (2005) carried out an interview study on eight advanced-level pianists based in Quebec, and asked them to define ten adjectives from a given list (69 French descriptors and 73 English descriptors) that could be reproduced at the piano. The central aim of their study was to analyse the relative frequency of different timbre descriptors. During the interview, pianists were not only required to give an understanding of the descriptors via synonyms and antonyms, but also to demonstrate how to produce the desired timbral effect via bodily movements. Physical aspects were explained such as the influence of the centre of gravity on bodily movements and positions, the control of finger attack and the corresponding speed and depth into the keyboard. The method of interview that uses live demonstration has strongly influenced my study design, since knowledge and memories may be recalled through the process

of performing. Bernays (2013) interviewed four advanced-level pianists, and asked them to give their musical and technical understanding of five given musical pieces. In this study, musical interpretation and understanding were important factors in the production of piano timbre. Timbre was not merely studied from an acoustic perspective, but also by integrating musicians' thoughts and feelings into the examination of the sound.

The above two studies on piano timbre started to consider the aspect of performers' gestures and combine quantitative methods and qualitative methods. However, they failed to consider the pianist's bodily sensations and impressions in the performer's gestural control of timbre production. For example, the qualitative insights into the performers' control only considered playing techniques (i.e. pedalling, dynamics, touch, and articulation) such as: 'A round timbre is neutral, not too loud, with hands well balanced; while a dry timbre involves a short articulation, no pedal and some rubato' (Bernays, 2013, p. 241).

Holmes (2011) conducted an interview study with one professional guitarist, with the aim of exploring the artistic and aesthetic function of timbre from that performer's first-person perspective. Her main focus was on the performer's personal and emotional interpretation and communication of the musical structure, along with other relevant aspects, when preparing and playing the musical piece; this interview study was therefore investigative rather than comparative. This study revealed the motivation for employing timbral nuances in an expressive guitar performance – the performer's emotional response to the music, and the feeling of a deep involvement and fascination with sounds. From a methodological point of view, Holmes stated her reason for choosing the less popular qualitative method in timbre research: she argued that control over timbre is multifaceted and continually evolving from the angle of the performer, and that this makes it challenging to obtain measurable and quantifiable data.

The literature that has been reviewed so far indicates different approaches to the study of timbre perception, such as psychoacoustic approaches (e.g. Handel, 1995), a combination of

linguistic and acoustic approaches (e.g. Bernays & Traube, 2014), and phenomenological approaches which are concerned with the performing body and body sensations (e.g. Holmes, 2011; Doğantan-Dack, 2011). Practical lessons learnt from the reviewed studies have influenced several aspects of this study, such as the design of interview questions and the use of a combination of mixed research methods. For example, the interview questions are not only concerned with physical aspects such as playing techniques and bodily movements, but also contain introspective aspects such as subjective feelings and bodily sensations.

This thesis will largely adopt a phenomenological approach to the study of piano timbre, but with a mixture of qualitative and quantitative methods. The phenomenological aspect of this thesis considers how the performers, teachers, and students reflect their experiences and feelings: for the performer, how the body prepares itself or behaves in response to a given timbre concept; for the listener, how previous bodily experiences influence the perception of piano timbre; for the pairings of teachers and students, how timbre targets are realised and conceptualised in piano lessons. However, the study is not based purely on a phenomenological approach, but is strengthened by objective measurements. For example in Study C (see Section 6.4), the research focus is on real-time behaviours (talking, playing) and real-time processes (e.g. how timbre targets are approached). It works as an objective tool to investigate the communication of piano timbre in a real work setting.

6.1.2 From sound-oriented to body-oriented approach

The last section highlighted the importance of the performing body in piano timbre studies, which is the so-called body-oriented approach in my thesis. I will put emphasis on the performer's body rather than the performed sounds in my overall research. This means that the sound analysis of the extent to which various touch qualities influence the spectral information of sounds is no longer at the centre of my research. On the contrary, the performer’s utilisation and awareness of bodily movements in piano playing is my primary concern; how pianists describe, interpret, and reflect

their bodily movement and experience is a window through which to explore their first-person perspective on mind-body unity in the performing arts. I will introduce the notion of body awareness in this section in order to emphasize its role in understanding mind-body integration in the art of piano playing, which is consistent with one of the central aims of the thesis.

Empirical study on the performer's body in the research of music performance started with Jane Davidson (1993; 1994; 1995), who noticed the importance of the visual component of music performance in the evaluation of musical expressiveness. Since then, systematic examination of performer's gestures has become of increasing interest to scholars aiming to reveal its close connection with musical expression and communication. As pioneers, Clarke and Davidson (1998) compared MIDI-data of piano performance and the movement data taken from video-taped recordings, to examine to what extent the continuous change of timing and dynamics in a piano performance correlated with the change of horizontal position (backward/forward) of head and hand gestures. This study found that the pianist adopted a more forward movement when he wanted to convey a sense of more 'inner' and intense interpretation of the music. However, this study raised a thought on the methodological approach to study the performing body in my own research: since part of performers' bodily movements are carried out in a conscious manner, do performers consciously move forward into the piano to create intense interpretations? How do performers notice, differentiate and discern between body sensations that happen at a personal level (e.g. changing positions) and sub-personal level (e.g. changing the centre of gravity). It is therefore interesting to explore the body awareness in the process of tone production. Asking participants about the intention behind their movements and how this relates to performance avoids the dualism of action and perception, and of the mind and the body.

To begin with, I would like to put the notion of body awareness into the context of everyday life and then, specifically, in the context of playing the piano. Body awareness is a subjective aspect of humans proprioceptive and interoceptive feeling that leads to consciousness, and is

influenced by mental factors such as attention, interpretation, appraisal, beliefs, memories, affect etc. Enhanced body awareness is a crucial component in therapeutic approaches including Yoga, Tai Chi, meditation, Alexander methods, breath therapy etc. that are used to reduce anxiety, stress, and pain, as well as to increase feelings of peacefulness and well-being. Mehling et al.'s study (2011) found that a shift in awareness of bodily sensations during the therapy process can result in a change in how patients responded and related to sensations, and that as a result patients learnt how to notice and differentiate between bodily sensations, cognitions, and emotions. More importantly, this study suggested that body awareness becomes an indivisible part of embodied self-awareness which is accomplished in actions and interactions with the external living environment, i.e. a switch from having a body to being the body (Mehling et al., 2011). The attention on body sensations has become a solution used to resolve mental-health problems as is the case in psychoanalyst Lombardi's clinical work which used body-focused treatment (Blechner, 2011).

Moving away from clinical settings, body awareness and body sensation are also key notions in piano playing and pedagogy. Just like the therapeutic function of reducing tension, approaches based on T'ai Chi and Alexander technique have been reported to be widely used in a piano playing and pedagogy context. In the book *The beauty of gesture: the invisible keyboard of piano & T'ai Chi*, pianist Catherine David (1996) introduced her experience of using techniques from T'ai Chi as a strategy for piano playing. She shares her experience of how a shift in awareness of bodily feeling has had a positive effect on muscular injury: 'Awareness of the sensation is in fact the only way to dismiss boredom and convert muscular pain into pleasure… Immediately, the arms round up more gracefully, the hands feel strong without tensing up, the fingers feel graceful, the wrist follows the forearm, the legs consolidate one's stance, the body runs into a silent piano.' (pp. 22–23). She also recommended that pianists ought to learn to discern bodily sensations and discomforts (e.g. a stiff neck, an awkward posture) and turn them into actions (e.g. to relax, stretch

out, lighten the shoulder and neck). These strategies align with therapeutic approaches such as breath awareness, repetition and training, refinement of noticing, discriminating and discerning physical sensations (Mehling et al., 2011). This study implied that body awareness has brought about changes in the actions that occur in response to these sensations; the actions in turn mediate and modify our perceptions, intentions, and emotions during piano playing. In this sense, the body and the mind are single unit; when playing the piano, gesture is not only controlled by the mind as the body carries out intentions and thoughts, as David described it: 'the body turns to a silent piano' (ibid).

To conclude, the body-oriented approach sheds new light onto the study of performer-controlled aspects of piano timbre. To study the performing body in piano playing, researchers need to understand body awareness, body sensations, proprioceptive feeling in the physical production of piano tones and its importance in constructing body-mind connections and demonstrating an embodied self in a living environment. The value of studying the performing body has been underestimated even in practitioners, as can be seen in the exercises and etudes used to practice finger dexterity such as those published by Czerny, Moscheles, and Clementi. A study of the performing body should not merely consider therapeutic and pragmatic functions such as preventing injuries, reducing tension, or improving technical skills, but should also consider theoretical and philosophical aspects, such as the debate on mind-body dualism, embodiment of musical experiences, and the music-motion association.

6.1.3 Overview of study design and research methods

This research adopts empirical methods to investigate piano timbre, by observing what is happening inside the performer's world of interpretation (Study A), the listener's listening experience (Study B) and interaction patterns between teacher and student (Study C). The data is then generalized and explained, with the aim of seeking implications for the fields of performance practice, audience experience, and music education – what is called turning data into facts (Cook

& Clarke, 2004). As Cook and Clarke (2004) clarified: 'Empirical musicology can be thought of as musicology that embodies a principled awareness of both the potential to engage with large bodies of relevant data, and the appropriate methods for achieving this.' (p. 5). This calls for the seeking of data-rich fields to investigate the perception and production of piano timbre with the matching methods, e.g. audio/video recording, audience questionnaires, interview data, participant observations etc.

Although the research questions and aims may not fully overlap between these three individual studies, research findings can be generated in a coherent and synthesised way. For example, the communication and expression of piano timbre in a piano performance are well reflected in each of the studies. Study A offers an insight from a first-person perspective, with regard to how the pianist reflects and perceives the production process of piano timbre (i.e. physical skills or mental skills) and what the relevant significance and meaning of gestures and movements are. Study B varies the effectiveness and accuracy of communication process via quantitative methods and experimental control. Finally, Study C explores the real-time process of communicating and making piano timbre. Aspects of the conceptualisation of piano timbre are equally explored in Study A and Study C, but the difference is the manner of data collection: Study A adopts a more phenomenological approach by asking pianists to reflect, while the Study C results are generated by segmenting a video-taped piano lesson into fragments where teacher and student set timbre as target of improvement, and the summarising of these timbre targets. The overlapping characteristics of these three empirical studies result from the multiple roles of musicians in musical practice. They are performers when creating music performance but they are also listeners that experience the performed sounds. They are teachers that give instructions and explanations but they were once students that learned from this experience and knowledge.

6.2 Study A: Interview Study

6.2.1 Study design

The first study in my PhD project was designed as an exploratory qualitative study, using a semi-structured interview to obtain in-depth descriptions of piano timbre concepts from advanced pianists. The literature review has highlighted the fact that pianists' concepts of piano timbre differ significantly from each other, and that musicians' conceptions of piano timbre differ from acousticians in terms of the function and causality of piano timbre. A semi-structured interview with guided questions helped to explore the multiple dimensions of pianists' comprehension of piano timbre.

Pianists were encouraged to demonstrate their understandings with performance. The schedule of semi-structured interview was divided two parts: the first part, focused on exploring pianists' general understanding and conceptualisation of piano timbre; the second, observation, part investigated the physical production of piano timbre including bodily movements, gestures, and touch, and was concerned with pianists' personal explanations and understandings during the demonstration process. Interviews, performances, and explanations of performance were video-recorded. Pianists were individually interviewed and observed in a single session which lasted for up to one hour.

6.2.2 Participants.

Two less advanced pianists helped with the interview pilot. This facilitated the reorganisation of interview questions and the time-control of the interview procedure. As concepts of piano timbre for pianists are developed over the years of specialized musical training, eight advanced-level pianists with a range of ages and nationalities (seven female students, one male student; three Westerns and five Asians; average age = 25.58, SD = 8.24) took part in the semi-structured interview and observation study. They were all postgraduate students in piano performance studies

in the Department of Music at the University of Sheffield; six were studying for an MA in Performance and two for a PhD in Performance. All of them had completed a BA degree in music performance, and two of them had been engaged in piano education for at least twenty years. They were taught by different piano teachers and came from different educational backgrounds. Interviewing student-pianists is helpful to explore the extent to which the concept of piano timbre develops as part of higher education teaching and learning. A pre-questionnaire about musical background indicated that participants had received continuous training in music and had been actively playing the piano from a young age (average years = 20.88, SD = 9.30). The background-information survey further indicated that participants played a broad repertoire not restricted to classical music, including accompanying vocalists, and performing contemporary and other ethnic music (Spanish, Latin, and Chinese).

6.2.3 Materials

An interview schedule was used asking participants to explain their understanding of piano timbre, using alternative or related terms, and to describe contexts in which they talked or thought about timbre. They were also asked to explain their thoughts on ways of producing various tone colours and their ideas on the importance of timbre in piano performance (see Appendix 2).

Interview questions. Eight basic, open ended, interview questions were included in the interview schedule, which explored the concept of piano timbre from different perspectives. The first question was concerned with subjective understanding of the concept of piano; for instance, asking pianists to give examples of synonyms and circumstances (Q 1–3 in Appendix 2). These open questions gave interviewees the freedom to reflect on their past and present performance and educational experiences. The second question explored the relevance of piano timbre in piano playing (Q 5–6), including the significance and importance of piano timbre, and the relevance to the interpretation of a musical piece. The third question was concerned with the physical production of piano timbre and the methods pianists used to facilitate that process, such as

imagination, metaphorical thinking, or perceptions from other sensory modalities (Q4, Q7, & Q8). I am also a pianist and this enables me to understand both the technical and artistic elements of the conversation with the participants.

In addition to the eight basic questions, several small, flexible, and unplanned questions were asked as a feature of the semi-structured interview. These emergent questions were mainly asked during the second, demonstration, part, and were concerned with real-time bodily sensations and awareness in the preparation and production of a timbral intention. Several strategies were used to facilitate the interview process. For example, the pianists were asked to explain the influence of hand shape or touch types on the produced timbre, and then encouraged to try opposite, or distinct approaches while giving feedback on how they felt about the sound and their body, and why it was not adopted or less preferred. They were also instructed to reflect on bodily feelings and intentions after playing (e.g. Have you thought about your gestures or postures when you were playing?). Talking while playing often occurred in the interviews as pianists needed to 'be in the moment' of playing to then be able to reflect on their experiences. A camera placed in front of the pianist captured and recorded the gestures, upper body movement, and recorded the sound.

Musical pieces in the demonstration section. Pianists were asked to bring a piece of music that they knew well or were studying at that moment (as shown in Table 6.1). It is acknowledged that a consistency of musical pieces (i.e. the composer, the period, or length) would have been helpful to understand the relationship between technical aspects of body movements (e.g. fingering, jumps) and basic musical structure or elements (e.g. scales, chords) (see Chaffin & Imreh, 2001); however, the interview was more concerned with the phenomenological aspects and interpretative dimensions of body movements in ways that are meaningful and have been experienced by the participant (e.g. subjective experiences, proprioceptive sensations). Therefore, individual choices were considered and there seemed no need for a systematic control of selected musical pieces.

Table 6.1. List of self-selected musical pieces.

Pianist	Selected pieces	Composer	Year
1	*Piano Sonata in A minor D. 784 2nd movement, Andante*	Franz Schubert	1823
2	*Doctor Gradus ad Parnassum*	Claude Debussy	1908
3	*Etude Op.42 No.5*	Alexander Scriabin	2007
4	*Piano Concerto No. 21 in C major, K.467*	Wolfgang Amadeus Mozart	1785
5	*1. Piano Sonata in E minor, Allegro Moderato*	Edvard Grieg	1865
	2. Poem	Zhang Nan & Zhang Zhao	2007
6	*Piano Sonata in C Major Op.2 No. 3, 1st movement*	Ludwig van Beethoven	1795
7	*Etudes-tableaus, Op. 39, No. 6 in A minor*	Sergei Rachmaninoff	1916
8	*Prelude and Fugue in F#, BWV858*	J.S. Bach	1722 or earlier

6.2.4 Interview procedure

The interview process consisted of two parts: firstly, participants were asked several questions around their understanding of timbre concepts, and secondly to demonstrate timbral differences on the piano provided; they were specifically asked to explain the methods they employed to produce certain types of sound. More specifically, pianists were asked to perform an excerpt from the music and explain their expressive intentions in terms of timbre, using a retrospective thinking-aloud procedure which gives insights into the performers' thinking process by working silently and thinking aloud (Van den Haak & De Jong, 2003). Similar to Caruso et al.'s (2016) 'what-how-why' approach, the pianists in this study were asked to reflect on which parts of the music carried timbral intentions and what timbres they pursued (i.e. what), what they did in order to produce the

different timbral effects (i.e. how), and the reasons of doing so (i.e. why). In special circumstances when the pianists got stuck in their reflections, they were encouraged to play the same extract with different/contrasting timbres and to explain the processes used to accomplish these. This may help to become more aware and deliberate about timbre (as employed in Caruso, 2018). The whole interview procedure lasted around one hour.

The interview started with warm-up questions, including those asking about participant's performing and learning experiences. For example: 'How long have you been playing the piano?' 'What kind of music do you usually play?' 'What has your musical journey been like?' Data analysis will not include these warm-up questions apart from any particular circumstances where participants answered something that was directly relevant to piano timbre[4].

6.2.5 Data analysis

The verbal data of the interviews and explanations were transcribed and analyzed using the method of thematic analysis (Marshall & Rossman, 1999; Braun & Clarke, 2012). A combination of an inductive approach (data-driven) and deductive approach (theory-driven) was used, as it is often impossible to be purely inductive or deductive (Braun & Clarke, 2012). The transcript of each interviewee was put into Excel with each phrase or line listed in a row (column 1) to sort data easily in later stages. It was firstly encoded line by line, by briefly summarizing main ideas (column 2) and indicating pre-existing codes where appropriate (column 3) as a first-stage coding. Subsequently, a bottom-up approach was used to seek for new codes that emerged from the data itself as a second-stage coding. The new codes were developed from a basic descriptive level (e.g. find an appropriate timbre for a musical passage) to a more abstract level (e.g. appropriation) (created in column 3). Finally, a comparison and categorization of all the codes was made to define overarching themes. Main ideas and codes were copied separately in a Word file and analytical

[4] In the beginning stage of the interview with Pianist J, she introduced her musical training background in both Classical music and Latin music. Right after, she started to talk about the timbral differences between the two musical genres.

memos were written to make connections of the codes and to find patterns of ideas. Themes were reviewed to check whether they fit the whole data set. As I have a bachelor degree in piano performance, this enabled me to carry out the inductive analysis with an understanding of both technical and artistic context (Holmes, 2012). As a secondary verification, my supervisor has checked the coding and demo that I came up with. Preliminary themes then developed into advanced themes.

Non-verbal information, including gesture and performance from video recordings was also analysed in conjunction with the verbal explanation. Hand gestures and body movements in the performance were described and noted, in particular when pianists referred to the body without giving explicit explanations (e.g. using here; playing in this way). Gesture analysis focused on the images made from the video extracts, when a pianist had different/contrasting timbral intentions in the same musical extract. Adobe Photoshop was used to extract the movement image from a series of motion sequences generated from video images. (See Figure 6.1).

Figure 6.1. Example of gesture analysis of pianist's (P8) hand movement in the interview study. Image was created in Adobe Photoshop by merging several layers of motion sequences.

6.3 Study B: Experimental Listening Study

Chapter 4 has formed the foundation of the experimental design of my study from two perspectives: Firstly, it discussed the experimental design to investigate the quality and accuracy of the communication process: for instance, changing audio-visual presentation modes, or employing

(in)congruent audio-visual stimuli. The listening experiment employed the first type of research design, to examine the accuracy of communication of timbral intentions to listeners and its dependence on visual and auditory components of music performance. Secondly, Chapter 4 highlighted sensorimotor communication as a special component of timbral communication in music performance and distinctiveness from emotional communication. The knowledge of cross-modal association also implied the association between timbre perception and other sensory perceptions (visual brightness, shapes, and size). This suggested that the design of the adjective ratings in the listening experiment should concern perceived qualities from multiple dimensions such as: texture, valence, shape, sensations, and weight. Ten timbre descriptors and non-verbal response paradigm were designed for this criteria (see Section 6.3.3 Materials).

6.3.1 Experimental design

The listening experiment used a within-subjects design, and participants with a piano performance background were shown all the performance excerpts in three states: audio-only, visual-only, and with both audio and visual information presented. They were required to rate to what extent each of ten timbres were expressed in each excerpt on 1–9 unipolar Likert scales. Unipolar scales were employed in the listening experiment, in order to create a less directive and opener response space for listeners, as I assumed the perceived timbral intentions may not just be singular (e.g. both tension and relaxation being perceived in the sounds; or neither of them was perceived). The dependent variable was the rating of each timbre scale, while independent variables were the factor of pianist/piece, the mode of audio-visual presentation and the instructed timbre. In total, there were three musical pieces x 3 AV presentations x 10 instructed timbres totalling 90 music excerpts. Each music excerpt lasted around fifteen seconds and each excerpt was performed by one of the three pianists.

The research design and data analysis method were largely borrowed from Timmers and Ashley's study (2007) of emotional ornamentation in performances of a Handel sonata. This study examined the utilisation of ornamentation by a flautist and a violinist when instructed with distinct emotional intentions (sad, loving, happy, angry), and investigated the accuracy of communication to listeners who were trained musicians. Instead of examining basic and common emotional intentions, my study examines the communication of ten timbral intentions, which tend to be more challenging and vague. Ghiena and Martínez's study (2017) confirmed that pianists are able to communicate more abstract instructions with a high degree of communication accuracy, such as floating, precipitate, hesitant, explosive, and gentle. It is therefore interesting to examine the communication accuracy of timbre-related intentions in my study, which may seem abstract and difficult to communicate.

Considering the experimental design in this study, the visual component of piano performance was presented in two ways alongside each other: a global view that showed the sitting pianists from the side, and a more local view that was focused on the hands and fingers. This study assumes that the perception of timbre is shaped by the integration of these two views. This also fits the realistic listening phenomenon that the attention of listeners does not always focus on the fingers or particular bodily movements – as can be seen with eye-tracking (personal participation in a workshop that employed eye-tracking at the RITMO centre, University of Oslo)[5]. The impact of visual information on timbral experience arises, therefore, as an outcome of a blended experience from two perspectives.

6.3.2 Participants

[5] The project details can be found at: https://www.uio.no/ritmo/english/projects/nordicsmc/events/conferences/2019/winter-school/projects/group-g/index.html

Performers. Three female Chinese pianists (age 23-37) from the Department of Music at the University of Sheffield were asked to give performances to create the stimuli used in the listening experiment. They were all majoring in piano performance studies (one PhD student, two Master's students) and regularly performed classical, baroque, and contemporary music as part of their performance repertoire. This study did not consider the use of recordings by professional pianists, because the participants in the listening experiment were also student-performers. As such it was interesting to explore timbral communication from performers that have similar performance skills and levels of training. The three performers were recruited following the previous interview study, and they all expressed great interest in participating in the present study.

Listeners. Twenty-one music students (nineteen females and two males; Mean age= 21.89, SD=2.03) from the music department at the University of Henan in China participated in the listening experiment. Fourteen of them were undergraduates and seven of them were postgraduates. All participants were majoring in piano performance studies.

6.3.3 Materials

Ten timbre descriptors. This study employed ten timbre descriptors (see Table 6.2 below), five of which were selected from the study of Bernays and Traube (2014), whilst the others are their antonyms. The validity of using the five timbre descriptors as performance instructions has been tested in their study with sound analysis and measurements of performance strategies (e.g. attack depth, speed, decay etc.) in five pianists. Their study indicated that there was no difficulty in pianists interpreting the same musical piece with distinct timbral intentions, and subtle changes in expressing different timbres were found by sound and keyboard motion analysis. Five extra descriptors were added in the present study, to generate five pairs of performance instructions with contrasting timbres in each pair. The descriptors of 'heavy' and 'light' represent a kinetic experience associated with piano timbre perception; 'relaxed' and 'tensed' relate to the muscular

sensations when responding to piano timbre. It is noteworthy that the contrast between 'velvety' and 'dry' was not noticeable; however, they described the characteristics of object surface and represent different types of tactile feelings. They did reflect either a positive or a negative appreciation of tone quality by pianists in particular circumstances: that finer motor control usually produces a velvety tone quality while dry timbres are less pleasant for pianists in a classical performance context (contemporary music is a different case).

Table 6.2. Ten timbre descriptors used in Study B (perceptual experiment).

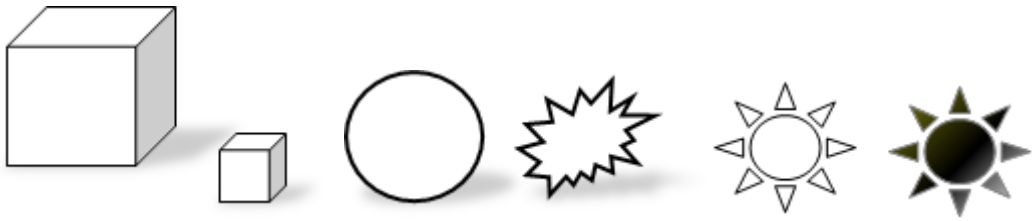
	Timbre descriptors	
Pair 1	Bright*	Dark
Pair 2	Round*	Sharp
Pair 3	Light	Heavy
Pair 4	Relaxed	Tensed
Pair 5	Velvety*	Dry*

Note: descriptors with * are from Bernays and Traube (2014)

Recordings. Three pianists performed one of three musical excerpts using ten timbres (bright/dark, heavy/light, relaxed/tense, round/sharp, velvety/dry), leading to a total of thirty performances, which were audio- and video-recorded. The music pieces were selected from the experiment materials used in Bernays and Traube's study (2014) (see Appendix 7). The pianists were originally asked to play all three musical pieces. To avoid boredom and an effect of repetitive listening on listeners' responses (Morimoto & Timmers, 2012), only one musical piece played by each pianist was selected to be included in the listening experiment (Piece 1 by pianist A, Piece 2 by pianist B, and Piece 3 by pianist C). Otherwise the listeners had to listen to the same musical piece thirty times (three performers play one musical piece repetitively using ten different timbres). When matching the performer and the piece, I considered the criteria of fewer mistakes and more

expression in the performances of each pianist, to optimize the quality of the musical material presented to listeners.

The response sheet in the listening experiment was paper-based (see Appendix 6). Apart from the adjective rating scales, this research was also interested in exploring cross-modal associations related to timbre perception. Non-verbal sensory judgement were therefore included in the response sheet (see Figure 6.2).



Pair A: size Pair B: shape Pair C: brightness

Figure 6.2. The experimental paradigm employed in the listening study to examine cross-modal correspondence (CMC) related to piano timbre perception.

6.3.4 Procedure

Performance recording. The recording sessions happened inside the Sound House Studio of the Department of Music at the University of Sheffield. The piano provided was a Yamaha grand piano (Disklavier pro S6) that is able to record MIDI-data of the performance (i.e. timing, velocity, and duration of each performed tone). Three pianists were given the pieces one month before the recording and each of them experienced a recording trial before the actual recording to enable them to get used to the cameras, the procedure, and the piano. The practice time also allowed them to seek for the appropriate performance manner for each special timbre. Instructions for performance were explained in both written form (see Appendix 3) and orally. To insure that pianists played in response to timbral intentions rather than other expressive intentions, the

objectives of recording their performances were clearly explained to them. They were told that their performances would be used as stimuli in a perceptual experiment in which the listeners would be pianist-students of the same level as themselves and that their listening focus would be perceived timbral quality. The original musical pieces borrowed from Bernays's study do not have any expression, dynamic, articulation, phrasing, and accent markings, which gave the performers scope to vary performance parameters to achieve a desired tone quality. Each performer was asked to play the three pieces of music, but their feedback on each performance was considered--the performance that they were most satisfied with and that they felt most engaged with was chosen.

Listening experiment. The experiment tested participants individually by presenting the recordings on a computer monitor. The monitor had a 15" screen and was placed in front of the participants within a comfortable distance (80cm–100cm). One vision-only file and one audio-visual file were chosen as practice trials before the actual listening test. I clearly explained that the video without sound would be normal rather than broken files, in order to test their judgement based on vision-only or sound-only states. After the practice trials, the actual experiment would begin. Recordings were presented over headphones. The playing volume level and playing order were set at the beginning of the experiment and did not vary during the listening test. Participants were encouraged to respond intuitively after experiencing the stimuli for the first time, but they could play the recording repeatedly if required, or they were hesitant about the answer. Majority of them played the stimuli just once and responded quickly, but two out of 21 participants took half hour longer than others due to unsure answers and replay of stimuli. The duration of the entire experiment normally took between forty-five minutes to an hour. In the middle of the experiment, there was a short break.

6.3.5 Data analysis

Percent correct. Participants gave separate ratings on a unipolar scale for each of the ten timbres when presented with one stimulus. The first objective was to examine whether or not they were

able to make an accurate judgement for each timbre (i.e. the rating of round timbre was highest among other nine ratings when presented with round timbre). We can calculate the percentage of listeners' correct responses for each timbre by re-coding data with either 1 (correct) or 0 (incorrect). The response was correct when the rating of the target timbre was higher than ratings of the other nine timbres when the listener was presented with the performance of a target timbre; for example, rated brightness for the bright performance is >= rated darkness/roundness/…/sharp for this bright performance. This is the absolute percent correct[6]. The response could also be coded as correct when the rating of target timbre was relatively higher for the performance with target timbre than in the other performances of a piece, for example rated brightness for the bright performance is >= rated brightness for dark/round/…/sharp performances of that piece. This is termed as relative percent correct answer. The relative as well as absolute mean percent correct scores for each rated timbre were calculated for each performer, each instructed timbre, and each listening condition (seen-only, heard-only, both seen and heard). The analysis of percent correct answers aimed to examine the questions of:

- How well did the performers communicate the timbre?
- Did the pianists differ in their ability?
- What was the dependence on audio-visual information?

One-sample T-test. A one-sample T-test was conducted to test whether the number of correct answers was above the chance level (10%). This is the chance probability that the rating of the target timbre will receive the highest rating of the ten timbres.

Three-way repeated measures ANOVA. Timbre ratings were entered into a three-way ANOVA with repeated measures for *instruction* (target timbre, opposite timbre), *AV stimuli* (audio-only, visual-only, and audio-visual), and *pianist/piece*. To simplify the analysis and assure statistical

[6] The method of calculating absolute and relative scores of percent correct answers is borrowed from Timmers and Ashley (Experiment 2, 2007).

power, the ability to communicate a particular timbre was tested per timbre pair rather than comparing across all ten timbre levels individually. Therefore, the first within-subjects factor was *instruction* consisting of two levels, which tested the difference in ratings for one timbre in response to either the target timbre or its opposite instruction. The second within-subjects factor was *AV stimuli* consisting of three levels (AO. AV, VO). The last within-subjects factor was *pianist/piece* with three levels (P1, P2, P3). Since different pianists performed different pieces, the main effect of pianist/piece indicates the influence of the pianist's interpretation of timbre, or the characteristics of the piece itself. Take the perception of bright timbre for example, the listeners' responses contained both perceived brightness when hearing bright performances (i.e. bright by bright) under nine conditions and perceived brightness when hearing dark performances (i.e. bright by dark) under nine conditions. Raw data were entered into SPSS (Figure 6.3), where the number 1-9 was simplified for the nine conditions: (1= P1, AO; 2 = P1, AV; 3 = P1, VO; 4 = P2, AO, 5= P2, AV, 6 = P2, VO; 7 = P3, AO; 8 = P3, AV; 9 = P3, VO).

participants	Brightby Bright.1	.2	.3	.4	.5	.6	.7	.8	.9	Brightby Dark. 1	.2	.3	.4	.5	.6	.7	.8	.9
P1	1	1	7	1	1	6	6	6	7	1	1	1	1	1	8	7	7	8
P2	5	4	5	6	6	4	5	7	5	6	2	7	4	5	7	5	5	1
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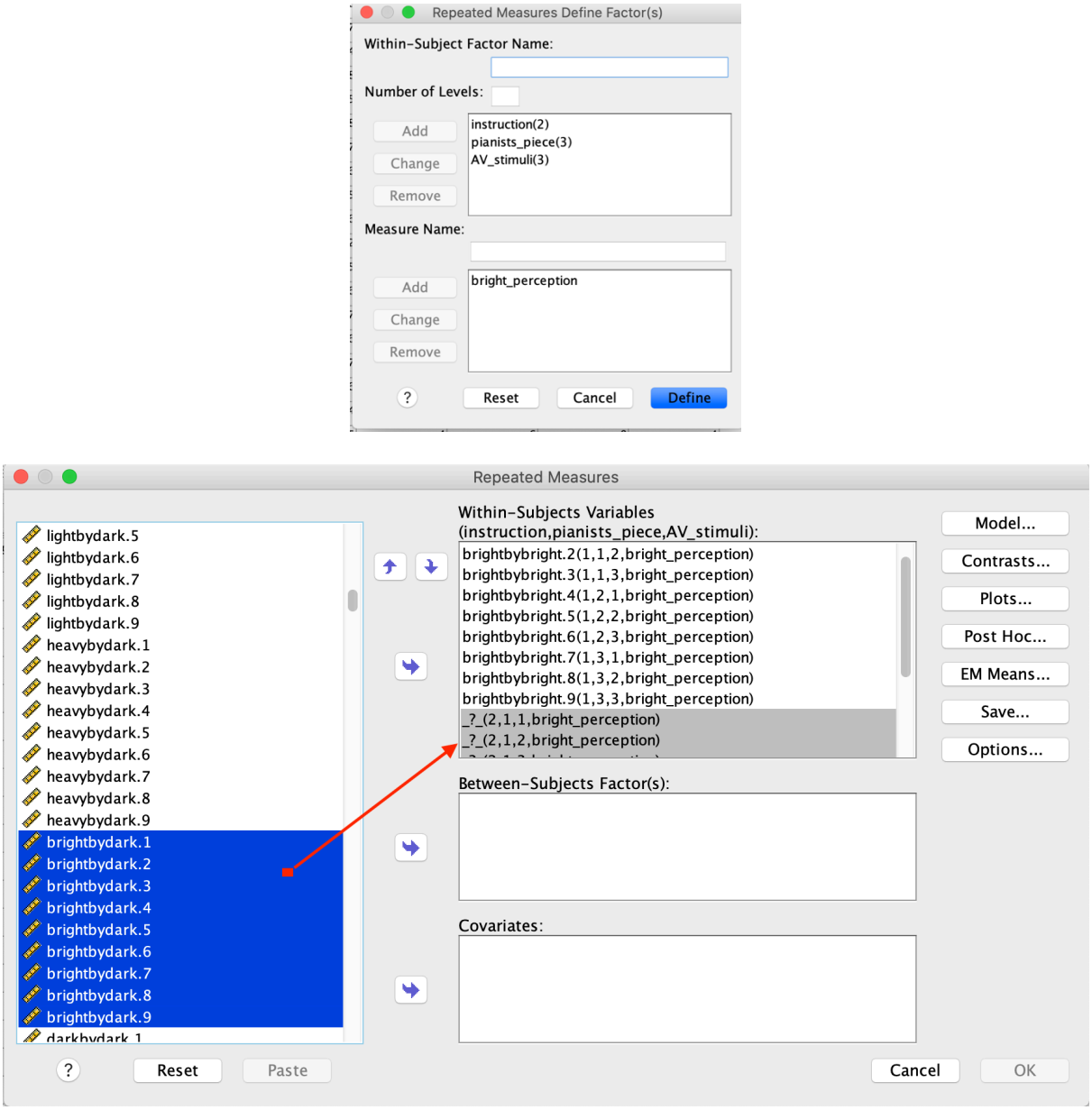

Figure 6.3. SPSS output of the three-way repeated measured ANOVA. Example of brightness perception.

Principal Component Analysis (PCA). Given that each listener was asked to rate ten dependent variables, a PCA was conducted to examine the underlying dimensionality of these variables. The results of the PCA indicated the clusters of timbre ratings.

Hypotheses. The following hypotheses were formulated for the analyses. The hypotheses of interest for the rating scales were in particular an effect of timbre instruction, interactions between timbre instruction and AV stimuli, and interactions between timbre instruction and pianist/piece

(see below). Main effects of AV stimuli or pianist/piece would mean that a certain timbre was overall more strongly present for a certain audio-visual condition or for a certain pianist/piece. A three-way interaction is also possible, which would indicate that the type of influence of AV stimuli on the effect of timbre ratings would depend on the pianist/piece.

Hypothesis for percent correct: pianists can communicate their timbral intentions above chance level in the audio-only stimuli, but with less accuracy compared to when presented in combination with visual stimuli.

Hypothesis 1, main effect of timbre instruction on timbre ratings: Timbre instruction will have a significant effect on listeners' judgements of the timbre dimension.

Hypothesis 2, interaction between effects of AV stimuli and timbre instruction on timbre ratings: The ability to communicate a timbre instruction varies with audio-visual condition.

Hypothesis 3, interaction between effects of pianist/piece and timbre instruction on timbre ratings: The ability to communicate a timbre instruction varies with pianist/piece.

Hypothesis for image choice: Instructed timbre will significantly influence the choice between contrasting images.

6.4 Study C: Observational Study

6.4.1 Study design

An observational study was conducted to analyse the teaching and learning of timbre in a semi-naturalistic context. Video recordings were made of three lessons with three groups, each consisting of a teacher and a student. Teachers were asked to teach the student as they would normally do in the first lesson; work specifically on timbre as part of the lesson in the second lesson; and add an element of dialogic teaching about timbre to their lesson in the final lesson. Pre-

questionnaires and post-interviews were included as part of the observation study, aiming to understand general views on the teaching and learning of timbre. Video recordings were analysed using a combination of quantitative and qualitative data analysis approaches.

Data analysis of the video recordings included qualitative analysis and quantitative analysis. Quantitative parts compared the time spent on timbre sessions and non-timbre sessions, and quantified the time allocation of the three types of teacher-student behaviours (teacher performing, student performing, teacher-student talking). Secondly, a qualitative approach was used to categorise broader topics related to the teaching and learning of piano timbre, and to identify the domains of verbal descriptors of timbre between the teachers and the students, from the selections of physical, musical, or cognitive dimensions. Qualitative analysis was conducted through the coding of transcriptions of teacher-student conversation. Non-verbal communication (e.g. physical touch, gestures, and reactions) in the video excerpts were noted by myself and inserted into the transcription using brackets.

6.4.2 Participants

Three teacher-student pairs took part in the teaching observation study. Pair A includes a female teacher (age = 45; teaching years = 20) with her student S1 (female; age = 21); Pair B and C includes a male teacher (age = 56; teaching years = 30) with two of his students S2 (female; age = 20,) and S3 (male; age = 17). All students were majoring in piano performance but at different grades. The student in the Pair A is a masters-level female student; the student in the Pair B is a female in her final year (year 4) of undergraduate study preparing for a recital in two months. The student in the Pair C is a first year undergraduate male and is differentiated from the other two groups with a lower performance level: the selected musical piece was also easier for him than for the other two students.

It is acknowledged that a larger number of participants would be required to obtain more representative findings; however, as the nature of this teaching observation was exploratory and

an extension of the first interview study, the small-scale study helps to get a more in-depth analysis of teacher-student interaction patterns and verbalizations.

6.4.3 Materials

Pre-questionnaire. A pre-questionnaire regarding the participants' background information (age, gender, performance experience) was collected before the observation study. The questionnaire included both rating scales and open questions, and aimed to explore general views regarding timbre teaching and learning of both the teacher and the student (see Appendix 8 & 9). For example, they were asked to indicate the time devoted to timbral targets in a piano lesson when teaching or learning a new musical piece. They were also asked to describe at least three factors that influenced their teaching and learning of piano timbre and to give further explanations. The factors were chosen from a given list of influences on timbre production, including musical factors (style, structure), personal factors (student understanding and skill level, teacher's instruction, and metaphor), and physical factors (weight, touch, and posture/gesture).

Sample questions in week 3. Teachers and students decided the music that they wanted to work on during the teaching observation, and gave me a copy in advance to let me note the bar numbers where the teaching and learning of piano timbre occurred. As this study was interested in investigating the potential of a dialogic teaching strategy in the learning and teaching of timbre, sample questions (see Appendix 11) were provided in the final week aiming to facilitate dialogue between teacher and student: 'What sort of timbre do you want to create?' 'How do you think of the timbre in this section?' 'What do you think of the difference between my (the teacher) timbre and your timbre?' The aim of the teacher's questions is to help the student to think about timbre and become more aware of the possibility to change timbre. Teacher and student can develop their understanding of timbre together.

Post-interview questions. Each pairing of teacher and student were interviewed for around ten minutes at the end of the final piano lesson. Questions were concerned with the reflection on the

process, approach, and outcome related to the teaching and learning of timbre targets over the three weeks (see Appendix 10). The pair of teacher and student were interviewed as a group. For example, the teacher was asked to explain the teaching objectives of the selected musical piece and the relevance to piano timbre; the student was then required to reflect upon the responses of the teacher (e.g. 'what have been learnt in terms of timbre', 'the most impressive or satisfactory moments in the lessons'). In the end, the teacher commented on what could be done or improved in the future.

6.4.4 Procedure

The participants were approached and recruited two months in advance of the observation study. They both expressed their interest and agreed to take part in the study. Information sheets about the study were provided and signed consent forms were collected in advance, so all participants were aware that the observation aims were relevant to the teaching and learning of piano timbre, before the recording of the lessons. I also explained to the teachers that the present study focused on the process of teaching and learning piano timbre, rather than on a comparison of their teaching approach to that of other teachers. Apart from that, the teachers were asked to teach the same musical piece and progressively work on it over the course of three weeks. The students were required to practice the music up to a high level for the best recording effect. They were given the observation schedule in advance of the recording:

- Working as normal in the first week
- Focusing on timbre in the second week
- Using dialogue teaching in the third week

Questionnaires were collected before the recording, and the post-interview was conducted at the last piano lesson when the teacher and student were both present. The three lessons for each pair were video-taped and sound-recorded during January 2018. The interval between subsequent piano lessons of the same group was one week, to enable enough practice time between classes.

All the lessons were recorded in the same practice room, which is equipped with a grand piano and has enough space on the performance stage for the placement of two cameras (from the front and side) and to let the teacher move freely. A pilot study between the male teacher and me was made one day in advance of the actual recording, to make sure that the setting (e.g. lighting, camera position, audio recorder, the chair) were appropriate and these were then kept consistent in the following weeks.

6.4.5 Data analysis

Time allocation. This study calculated the percentage of time dedicated to timbre teaching in a piano lesson via time allocation. An event of timbre teaching/learning was identified using the notion of 'rehearsal frame' (Duke, 1994; Colprit, 2000; Küpers, van Dijk, & van Geert, 2014), which starts from the moment a teacher identifies an aspect of the student's performance that needs to be improved regarding timbre, and stops at the moment when the specific goal is accomplished or changed to a new goal (see Section 5.6). In the present study, I used ELAN software to process the video recording, which is a platform that can mark the starting/ending points of a particular event with high precision and control (see Figure 6.4 below). In the end, there were 77 video excerpts of teaching and learning of timbre for data analysis, which lasted around 8742 seconds (2 hours 25 minutes 42 seconds). The conversations in these video excerpts were transcribed for further qualitative data analysis.

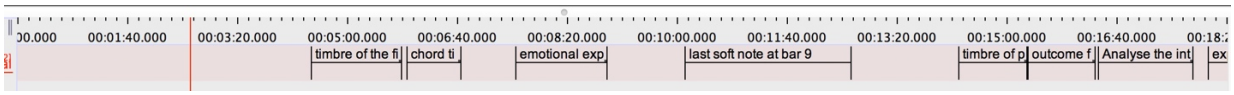

Figure 6.4. Platform in ELAN software to mark timbre sessions in video-taped piano lessons.

This study examined events when the teacher and student explicitly communicated about 'piano timbre'. Due to the diversity of verbalization of piano timbre and cultural differences, the verbalization of piano timbre in the Chinese context may also be replaced with a few terms such

as: 音质 (*yinzhi*, 'tone quality', 音色 (*yinse*, 'tone colour' or 'timbre'), or 声音 (*shengyin*, 'sound'), or 音 (*yin*, 'the tone').

Timbre topics. This study was interested in what the concept of piano timbre refers to in the real-time processing of piano lessons. Each timbre event was given a title (e.g. 'different touches to produce different timbres', 'timbre of the last note') to briefly summarise the teaching and learning objectives related to piano timbre. Data analysis was concerned with more advanced and higher level of categorisation of timbre topics.

Teacher-Student (TS) behaviours. The observation of TS behaviours includes three types: teacher-student talking (TS-talking), teacher performing (T-performing), and student performing (S-performing). The difference between performance sessions and talking session was easy to discriminate using the software Sonic Visualizer, with distinct sound-wave shapes and patterns (see Figure 6.5). Unclear fragments, such as soft volume or overlapping soundtrack of playing and talking, were double-checked with the video recordings to clarify who did the talking or playing. Data analysis was concerned with the time spent on each type of behaviour. The time devoted to TS-talking was not split into parts of T-talking and S-talking due to less talking of the students (less than 9% of the total amount of words in transcript). Instead, the analysis of the TS-talking was conducted in a qualitative manner.

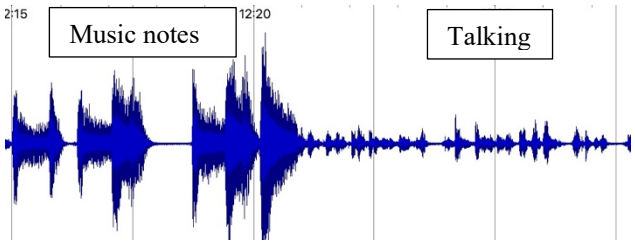

Figure 6.5. A screenshot of Sonic Visualizer.

Domains of verbal descriptors of timbre. This study examined to what extent TS-talking was related to the musical domain, physical domain, or cognitive domain. A full description of each

domain is given below. The coding scheme was taken from the studies of Woody (2000), Burwell (2006), and Colprit (2000).

- Physical-domain: descriptions of the use of the body, arm, and finger, as well as the energy, velocity, force, movement type. This is taken from the study of Colprit (2000) which discriminated between descriptors of physical behaviours (e.g. motion of the bow, fingering, spacing, position etc.) and musical descriptions.
- Musical domain: descriptions that are associated with musical parameters, such as musical tempo, dynamics, articulation, sustain or soft pedal, timing, musical phrase or structure. As mentioned above, Colprit (2000) referred to this domain as musical descriptions, but Burwell (2006) labelled it as literal vocabularies which are used to address issues of pitch, volume and structure.
- Cognitive domain: descriptions that are relevant to mental status, awareness, consciousness, expressiveness, emotional feelings, metaphors, images. Woody (2000) used the terminology 'feeling-oriented' in his paper to label felt emotions and moods; Burwell (2006) referred to 'metaphorical vocabularies' when referring to experiential, emotional, and figurative meanings. I integrated these two categories and complemented them with descriptions from a conceptual level including awareness, intentionality, and mental contents.

The main purpose of dividing and coding the text into these three domains was to investigate the proportion, and the role of, each domain in the teaching and learning of piano timbre. It will be also interesting to examine the difference in the proportion of each domain when referring to different topics of piano timbre. In other words, is timbre taught with reference to music-related terms that need extra information from other musical parameters? Is timbre explained with the aid of more physically-related terms that facilitate the production process? Or is timbre communicated

with reference to metaphors, emotions, or concepts that function at a higher level, to guide the timbre target? The answers will be revealed in Chapter 9.

6.5 Procedure of Data Collection and Analysis

The first interview study was conducted in the Department of Music at Sheffield University (UK); the second listening experiment and the third teaching observation study were carried out at the Department of Music at Henan University (China). Participants in the three empirical studies were all majoring in piano performance. The focus on a higher education context helps to get insights into the views and perspectives of mature performers, and also provides a convenient way for me to recruit participants and collect the data. Each empirical study was conducted independently without overlapping periods, so that the preliminary research findings from the latest study could be applied to the design of the next empirical study. For example, the initial stage of the literature review helped to formalize and generate the interview questions. The preliminary themes from the first interview study contributed to the generation of hypotheses of the perceptual experiment. The teaching observation study needed more time to recruit student and teacher participants, so it was designed as the last empirical study. The whole process of conducting three empirical studies is summarised in Figure 6.6 below.

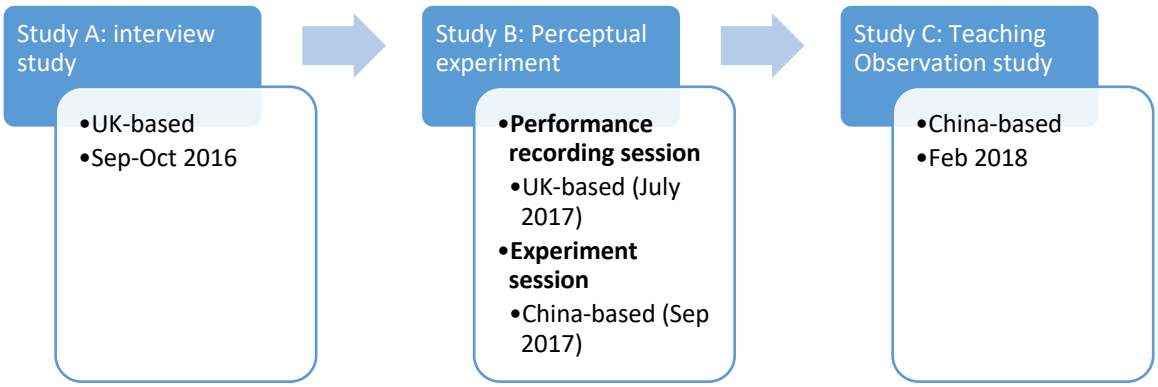

Figure 6.6. The process of conducting three empirical studies (location & time).

This research acknowledges cultural influence on the investigation of piano timbre. The third empirical study may reflect the cultural influence on the metaphorical descriptions of piano timbre and teacher-student interaction patterns. By contrast, the second perceptual experiment may reveal more universal patterns of cross-modal correspondence that related to piano timbre.

Interview questions were designed in English in the first interview study, during which English speakers responded in their first language, but the interviews with Chinese students were carried out in Mandarin. Both English and Chinese transcriptions of interviews were recorded but the coding process was carried out in English, including initial codes and higher-level themes. In the latter two studies, descriptions of rating scales in the listening experiment and the post-interviews in the teaching observation study were conducted in Mandarin. For the experimental study, participants reported no difficulties in understanding ten timbre descriptors which were translated from the English, and I was also able to find corresponding vocabulary when translating their descriptions of piano timbre into English.

Chapter 7: Interview Study on Piano Timbre: Conceptualisation and Production[7]

7.1 Background and Aims

The first empirical study was designed to explore the relationship between the body, the sound, and the mind in piano playing, from a first-person perspective. More specifically, this study helps to examine the following research questions: (1) How do pianists conceptualise the notion of piano timbre? (2) What is the relationship between a pianist's bodily movements and their subjective experience of produced sounds? (3) What contributes to the richness in conception of piano timbre? (4) What are the relevance of piano timbre concepts to musical expression and communication?

Eight advanced-level student-pianists took part in semi-structured interviews that aimed to explore their general understanding of piano timbre and the relevance to performance context. As an exploratory study, they were also asked to demonstrate their ideas with live performances in self-selected musical pieces, along with explanations, and reflections after the performance. Although the interview process was guided by eight basic questions, the interviewer asked flexible follow-up questions when the pianists gave interesting answers. Additionally, gestures captured by the camera were taken into consideration when pianists referred to bodily movements. The strategy of thematic coding was used to generate the themes of the interview study.

7.2 Themes Overview

Emerging themes from the interviews are listed in the left column of Table 7.1, and then grouped into advanced themes in the middle column. The frequency of occurrence of initial themes is

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indicated in brackets and was generated using NVivo. The themes relate to explanations of the conceptualisation, production, and relevance of timbre, as noted in the right column. Each of these themes will be explained in the following sections.

Table 7.1. Emergent themes, advanced themes, and the thematic groups in this study

Initial themes	**Advanced themes**	**Thematic groups**
Timbre concept as a combination of things (12) Timbre perception as influenced by other performance parameters (15)	Holistic concept of piano timbre	The concept of timbre
Timbre is performer/composer/style-specific (24) Timbre as interpretation of composer's intention (9) Piano timbre as orchestral sounds (7) Timbre associated with visual imagery/movement and feelings (19)	Conceptualisation of variations in piano timbre	
Timbre production needs full attention/concentration (5) Making timbre needs aural sensitivity (6) Timbre production as playing consciously (15)	Mind-body coordination	The production of timbre
Playing timbre as speaking/singing and hands as the articulator of sounds (15) Bodily tension/release felt as timbral tension/release (9) Feeling bodily weight in sounds (9) Moving gestures makes sounds move (6)	Embodied experience of timbre production	
Expressing timbral intention as communicating to audiences (6) Make listeners engage and move (10)	The communicative aspects of piano timbre	The relevance of timbre
The aesthetic value of piano timbre (5) Timbre relates to lifelong learning (9) Teaching timbre physically works better (7)	The significance and learning of piano timbre	

7.3 Conceptualisation of Timbre

Explanations of the participants' understanding of piano timbre made clear that pianists held a holistic concept of piano timbre seeing it as closely linked to other musical parameters. Furthermore, timbre was seen as characteristic for specific performers or composers. It was deemed fruitful to draw parallels with other instrumental performances, as well as with visual imagery, movement and feelings more generally. These themes will be briefly discussed in turn, followed by an intermediate summary that discusses the degree to which these notions show an integrated mind-body perspective.

7.3.1 Timbre as a holistic concept.

The pianists seemed to take a holistic perspective on timbre: they referred to broader musical sections (such as phrases or melodic ideas) rather than individual notes when explaining piano timbre, and to multiple performance parameters. Pianist 1 (P1) described the concept of timbre as the 'acoustic *journey* of loudness and softness'; while pianist 5 (P5) related timbre to other musical elements such as 'melodic contour, music fluidity, and breath in a *phrase*'. This suggests a connection in the minds of the pianists between timbre and musical structure. Indeed, piano timbre was interpreted as the combined outcome of performance parameters (timing, articulation, and dynamics), and musical elements (rhythm, harmony, and pitch). As explained by P3, piano timbre is a 'by-product of the combination of all elements'. In this way, the concept of piano timbre relates to the question of *what is the sound of the music* (timbre defined by the music material), and also *how to bring out that sound* (timbre determined by the performer).

7.3.2 Timbre as performer/composer/style-specific.

Closely associated with this holistic or inclusive perspective on timbre is the notion that the sound of a performance is composer and pianist dependent. Several pianists in the present study described piano timbre as the sonic impression of music performed or composed by a particular pianist or composer, for instance, using phrases such as, 'Argerich's sound, or Rachmaninoff 's sound'; 'bright [timbre] is Mozart; dark [timbre] is Rachmaninoff' (P4). Pianists emphasized the individuality of piano timbre, as a performer may 'use an individual sound palette', or 'have their own interpretative ideas' and 'distinct playing techniques' (P3). When characterizing the timbre of a particular genre, period or pianist, an association was made between timbral outcomes and gestures. P1 suggested that the timbre of Latin music is different to that of classical music, as Latin music requires a more angular, forceful and vibrant performance technique which involves the extensive utilisation of the wrists and arms; while classical music is played with a more delicate

touch which requires more focus on finger movements. It was also recognized that, as P3 argued, historically, piano timbre was richer than in the modern time-period with modern pianos.

7.3.3 Timbre as interpretation of composer's intention

At a more detailed level, pianists tended to associate timbral intentions with the interpretation of the musical score and musical ideas, in accordance with the presumed perspective of the composer. Several of the participants mentioned that knowing the compositional background and narrative helped to produce timbral intentions (P2, P5, and P7). They aimed to find an appropriated timbre for a particular piece and composer (P3), and P7 mentioned that the performance timbre should be as if the composer was playing:

> …Well it is not a beautiful sound. As my teacher said, it is an appropriate sound for that moment. Yes, not having a beautiful sound and staying with that. You find a good sound for Chopin, and a good sound for Beethoven. They all have different sounds in different pieces, well, having a range of sound. (P3)

7.3.4 Piano timbre as orchestral sounds.

The notion that the piano is like a miniature orchestra and can represent a range of orchestral sounds was mentioned in the present study. Four of the eight (P2, P3, P7, and P8) pianists argued that the piano is able to make string sounds, drum sounds, and vocal sounds, because of 'its register' (broad pitch range), and also the possibility of 'imitating and transferring playing techniques of other instruments' (P2). The intention of imitating an orchestral sound may start from the analysis of the composition (i.e. what instruments are being imitated), and is enhanced by using appropriate touch. In addition, similarities in the sonic level (note length, articulation, and dynamic level) and physical movements needs to be considered for the imitative effect. For example, P2 explained her intention of imitating a drum sound on the piano by choosing appropriate physical movements to achieve similar sonic effects: 'If it is a drum, for me, it is very percussive...First you have to listen

to how loud it is –the tension. And you have to think whether you use the finger or the whole arm. So it is for the pianist's body to control the sound.'

7.3.5 Timbre associated with visual Imagery, movement and feelings.

Pianists frequently spoke about piano timbre in terms of an image or gesture: for instance, P1 described the timbre of a 'rising melody' as 'riding a horse uphill'; and P7 explained the detached performance of higher notes as 'little red riding hood jumping' and legato performance of lower pitches as 'a wolf walking'. In both cases, the original musical structure (pitch, articulation) influenced their impression of produced timbre, and the musical sounds are metaphorically mapped onto physical movements which reflect riding, jumping, and walking. Pianists used knowledge from one domain of experience (physical movements) to structure another domain of experience (musical notes), creating a blended space, where sounds and imagery interconnect (Zbikowski, 2002). In this case, the mapping of a 'rising melody' as a 'riding a horse uphill' could be the visual analogue of a rising trajectory of notes written in the score, along with a kinaesthetic analogue of moving the hands. The mapping of the 'detached notes' of 'little red riding hood jumping' may be primarily based on a *kinaesthetic analogue* of the detached notes felt as jumping and jerky hand movements.

In addition, apart from visualizing the piano timbre as a musical gesture, pianists made reference to a particular circumstance that represents an intended feeling. For example, bright timbres were associated with happy emotions like 'children playing in the background'; in contrast, dark timbres were related to sad emotions as if 'sending the son to the hospital' (by P4).). For those who did not come up with specific images, various piano timbres were associated with colours: P2 imagined a dreamy sound as 'sweet, softening, baby blue'; P6 related a dry timbre to a 'khaki' colour representing the feeling of solemn and serious. Two pianists argued that imagining a precise and definite image does not help with timbre production. Instead, they preferred to examine 'the music narrative and melodic contours' (P6), and argued that 'piano performance is

very much physically based' which relates to 'emotional intensity', and is called 'non-propositional feelings' (P3).

7.3.6 Intermediate discussion of conceptualisations of piano timbre

The holistic perspective that pianists take towards piano timbre integrates different elements of musical sounds at a particular moment and across time. There is a sense that timbre may come forth from the overall interaction of all elements, which is also responsible for shaping performer, composer and genre specific timbre qualities. This is in line with work by, for example, Hamilton (2012) who associated tone colour with 'the illusion of different hues by dynamic contrasts and shadings' (p.59) and Bernays and Traube (2014) who defined the notion of piano timbre as subtle tone combinations via the expressive use of timing, dynamics, and pedalling, among others. The extent of this integration goes beyond sounding musical properties only, as becomes clear in the subsequent themes. Indeed, several types of blended spaces are being brought forward: a blending between instruments and manners of instrumental sound production; a blending of visual, sonic, and performative elements, and a blending between feelings, imagined scenes, and timbre. Movement and gesture seem to form a bridge between domains: performance gestures are imitated (percussive articulation, energy, duration), and scenes of movements are imagined and translated. Different modalities are relied on to make timbre conceptualisations more concrete, including visual, emotional, physical and gestural. To translate these to performance, motion and movements seem central.

In the next section, when discussing timbre production, the embodied nature of concepts of piano timbre becomes even more apparent in pianists' emphasis on the relationship between mind and body, the transfer of corporeal feeling into sound, and the use of physical attributes to link bodily movements to piano timbre.

7.4 Timbre Production: Mind-Body Coordination

One of the first aspects that was considered when talking about the production of piano timbre was the effort, precision and concentration that it requires. Secondly, several processes were discussed that allowed for different timbres to be produced, including conceiving the hand as articulator, and deliberately using the body (in various ways) to accomplish timbre intentions. These themes will each be briefly discussed.

7.4.1 Timbre production needs full attention/concentration.

The state of being concentrated on the production of timbre was described by pianists as being 'in the music' (P2), or 'concentrated in practice' (P5). By contrast, the less concentrated state was interpreted as being 'purely finger movement' (P5), 'like a robot' (P6), or 'absence of mind' (P4). In addition, pianists emphasized that the concentration in the making of timbral nuances relates to the aspect of aural sensitivity, for example the need to 'attend audibly to the piece' (P1) and the ability to train your ear to become more sensitive to 'hear the difference' (P4).

7.4.2 Timbre production as playing consciously.

Pianists referred to timbre production as a result of playing consciously in performance, including conscious body movements and conscious expressive intentions. P1 described that timbre production at an early stage of practice is about how to move the body consciously: 'When you are starting a piece, you are conscious of everything – the movements you start to make, your hand position, your shoulder, where you are playing from, which region of your body is involved – because you are in the experimenting stage'. Timbre production also needs an explicit interpretative intentionality, for instance, 'know your direction', 'know what you are doing, like clearly [know] why you want to do this and that' rather than 'expressing feelings' (P2), and the need to 'have a clear structure in the performer's mind – what is subject, and what is answer' (P6).

The ideas of concentration and intentionality lead to an interesting question here, of why pianists emphasized the importance of the 'presence of mind' when discussing the physical

production of timbre. This section suggests that for timbre to be successfully produced a strong coupling needs to be established between awareness of the body (i.e. proprioceptive information) and sonic outcomes. Through a coupling between perception and action, aural sensitivity can be fostered, and timbral outcomes fine-tuned. Previous research has shown that a better effect is obtained by focusing on 'sounds' rather than 'movement itself' (Kochevitsky, 1967; Duke, Cash, & Allen, 2011); this is also applicable to other types of performance that involve skilled movement, such as skiing and golf (Wulf & Prinz, 2001). However, this may need to be reconceived as a focus on 'sounds as movement goals' (Schiavio, van der Schyff, Kruse-Weber, & Timmers, 2017). Schiavio et al. (2017) argue that early musical behaviour develops in 6-month-old baby and onwards as part of the discovery of making and playing with sounds. This paper proposes that babies may not possess knowledge that is specific to music until they engage in musically-relevant actions. They argue that musical knowledge is developed by exploring the external environment through sound discovering: 'The more they explore the environment, the more they discover sound-related properties inherent to it, and the actions required to produce and manipulate such properties in various ways' (p. 12).

7.5 Timbre Production: Playing as Speaking

A second frequently observed method to produce timbre was to draw a parallel with speaking. Pianists imagined and symbolized the *hand shape* as a *mouth shape,* and described the playing of sounds as *pronouncing*; the space between the hand and the key was described as 'where the sounds come from'; and there was an idea that this space 'determines the richness of sounds' (P1). More specifically, P1 suggested that a higher hand position increased the hand-key space and was 'pronounced enough' to bring out a rich sound. P2 argued that flat fingers decreased the hand-key space and were good to make a dreamy, blurred and more legato sound (see gesture examples in Table 7.2).

> To me, [playing with flat fingers] sounds a little bit hollow, for me it is not pronounced enough to start the opening of a phrase, because as a starting phrase you want to signal that you are there. To me, [playing with flat fingers] just sounds like a little bit pathetic [laughter]. (P1)
>
> It is a more magical, dreamy atmosphere. Dreaminess is about blurring. If it [the hand] is high, it would not be dreamy anymore; it will be like attacking, like speaking 'Ta-Ta-Ta' [clearly and loudly]. (P2)

Furthermore, pianists also drew links with vocal expression in the articulation of pitch height and melodic contour. P2 related the hand position (high/low) to the pitch height in speech when she played, in her words, a deep, low, elephant-like sound by using a relatively low wrist/hand position (See gesture example in Table 7.2). This relates to everyday experience, as people use a lower position of the larynx to speak lower pitched words.

Last but not the least, this pianist suggested that the performance of a melody should be 'natural, like speaking' in terms of accent and fluidity in spoken sentences and musical sound.

> I always say 'do you want to eat [with the pitch going up ↗️]'. But it is not 'do you want↘️ to ↘️eat↘️?' It sounds weird! It is not natural… Music cannot be that. So I always do [it] this way: if you can imagine in your head how to do it in speaking, then you know how to do [it] on the piano. (P2)

These parallels made with vocal expression correspond to findings in studies of piano performance and pedagogy regarding the idea of creating 'a singing voice' as an ultimate target for pianists (Doğantan-Dack, 2002). The examples illustrate how 'a singing voice' may be obtained in piano performance by regarding the positioning and movement of the hand as *articulators* of the sound. Additionally, the parallel between playing and speaking in piano performance reveals how a seemingly metaphorical description of piano timbre becomes an embodied experience: imagery

and thoughts (e.g. dreamy; elephant-like) are mapped onto vocal actions (e.g. pronouncing, speaking in a low/large voice), which, in turn, become hand-actions.

7.6 Timbre Production: Bodily Movement Contributes to Timbre Perception

The last and largest theme within the discussion of the production of timbre was the role of bodily movements in the realization of timbre intentions, and the implication that moving in certain ways gives rise to corresponding timbres. This corresponds with the idea that corporeal intentionality is involved in timbre production *and* perception, at least in so far the pianist is concerned. In particular, pianists addressed uses of physical and sonic tension-release, weight and motion.

7.6.1 Bodily tension/release as timbral tension/release.

The corporal feeling of tension and relaxation in a performer's body might be transferred to the perception of timbre. In particular, the strength or firmness of hands/wrists was interpreted as influencing the timbre production. A fixed hand position and arm causes a 'fixed', 'restricted', and 'frozen' sound (P3; P4; P5); while a relaxed and fluent arm movement produces a 'ringing sound', like the movement of 'dropping' (P3) and 'play with gravity' (P5). Nevertheless, a certain degree of muscle tension is necessary to create the intended sounds: according to P5, a 'soft' sound is differentiated from a 'hollow' sound since the latter one is played with weak and loose hands without any tension and control inside; while a true 'soft' sound is played with certain tension and pressed with depth to make the string vibrate (P5). Similarly, a 'loud' sound is played forcefully but with a certain control and tension in the hands, so as to produce a 'firmer, tighter, and stronger' sound. In contrast, a harsh sound is played loudly but without any restraint, like the action of 'beating the piano', so the produced sound is 'dead, harsh, and crisp'. In these cases, P5 associated the bodily feeling of 'weak and loose' with a hollow sound, and also related the restrained and firm hands to a firm and strong sound. These movements may be relevant to differentiating between more, or less, appropriate playing techniques. The explanations were however always closely coupled to the production of appropriate and intended sounds.

7.6.2 Feeling bodily weight in sounds.

Body-sound associations were also apparent in the use of body weight to influence piano timbre. Although weight is closely related to the dynamics of performed sounds, pianists were convinced that the way in which bodily weight is applied influences timbre production in a way that goes beyond a loudness difference. For example, more weight from the arm and shoulder makes the sound feel 'supported underneath' (P1); musical chords that are played with heavier and larger movements sound 'thicker' and 'fuller' (P6).

The description of weight was further often linked with 'tension' in pianists' narratives; the words 'weight', 'force' and 'tension' were used interchangeably when referring to the same characteristic. Pianists employed different tension and weight in each finger and different hands to 'bring out the melodic line' (P2) or to 'bring out the timbre of that chord' (P3). This feeling was described as having a spatial dimension, in P3's explanation: 'So it is like a mixture of spatial things – I tried to get a background colour, and then melody notes come out.' The rotation and transfer of weight to different fingers influences the performed sound. According to P4, straight and fixed hands cannot differentiate the power in each finger; while rotation of the wrist helps to transfer power to certain fingers and bring out the melodic line in a polyphonic context, as if the music is flowing.

These descriptions are closely related to details of pianistic technique. For example, Hamilton (2012) clarified the difference between finger touch, hand touch, arm-weight touch, and full-arm touch, suggesting that full-arm touch is recommended for heavy work and finger touch is reserved for the lightest grade of tone. Discussed techniques may indeed influence the sound by, for example, influencing the relative intensity of tones within a chord. Nevertheless, there is a strong sense of merging of playing technique and sonic outcome. The following examples of moving gestures creating moving sounds illustrate this most strongly.

7.6.3 Moving gestures make moving sounds.

Pianists related different qualities of touch to timbral intentions and outcomes, and they often referred to techniques by indicating movement direction, such as 'pushing' and 'sliding' (P6), 'moving forward' and 'spreading' (P8), and 'falling through' (P4). These impressions of gestures and touch qualities were described as affecting timbre, resulting in the perception of 'moving' sounds. P8 described the timbre of a chord as moving when played with a 'pushing' gesture:

> The timbre of two equally loud chords would sound differently if I use different playing techniques. If I play in this way [with tensed arms], the timbre is tense and tight; It is significantly different from playing in this way [pushing forward], the sound is *moving forward*, which sounds better.

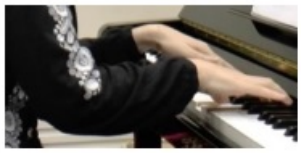
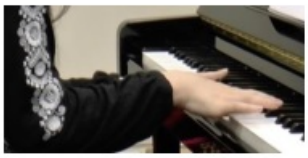
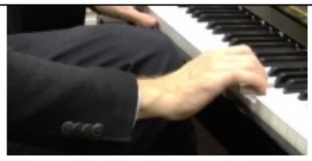
Pianist 3 suggested that the gesture of 'falling through' the key made the sound travel (gestures are shown in Table 7.2):

> For a soft sound, my teacher said you still play with the full body, but it's much more released; she said to think *down through* the keyboard, so it's very much kind of *falling through*, rather than just playing here [fixed]. And I don't think it is just psychological, I think there is a difference in the sound. So it means you can play with a kind of contact that is a kind of sound *travel.* (P3) [emphasis added]

7.6.4 Gesture examples and sound analysis.

To illustrate these points further, Table 7.2 includes examples of the movements and hand positions that pianists made in their explanations of the production of certain timbres:

Table 7.2. Examples of gestures of pianists in the creation of contrastive timbral intentions in a musical excerpt.

Pianist	Gesture	Contrastive playing
P1	 **Higher** hand position relates to a rich finger-key space, making the sound "open and rich".	 **Flat** fingers decrease the finger-key space, making the sound "hollow and apathetic"
P2	 **Lower** wrist position helps to play a "deeper" and "elephant-like" sound	 Instead of using a **higher** wrist .
P3	 A soft sound played in a way of "**falling through** the keyboard" and with certain finger tension, which makes the sound "travel".	 Instead of using **restricted** fingers.
P6	 A "**sliding**" movement makes the detached notes sound "softer"	 Compared with playing in rapid but non-expressive gesture which sounds "shorter" and "straight".
P8	 The sound is "moving forward" by **pushing forward** into the keyboard.	 The sound of a chord is "going straight down" by "just **pressing down**" without pushing forward.

7.6.5 Intermediate Discussion of Timbre Production

Production of sound colour and timbre was described as demanding a concentrated effort to create and fine-tune the intended sound, requiring a high level of auditory sensitivity. Such fine-tuning is only possible through careful control of the piano, and we argue that the concentrated effort to

moderate sounds is to align expressive intentions, bodily movement, sound production, and sonic effect. An implication of this perspective is that active exploration and performance is a necessary part of increasing auditory sensitivity, which goes beyond what our participants reported, but may be verifiable in future investigations.

Sophisticated techniques were employed to create intended sounds, including the use of hands and fingers as articulators. Appropriate levels of bodily tension and movement was used; hands, fingers and body positions were adjusted to create sounds with appropriate and often analogous qualities. The notion of the hand as articulator relates to previously observed uses of phonetic sound production as a model to vary instrumental timbres (Nykänen & Johansson, 2003; Traube, 2004). In the case of guitar and saxophone performance, the produced sounds may indeed change accordingly, as evident from analogous changes in formant structure. However, in piano performance, such analogous changes are less likely given the inherent restrictions of piano timbre. Nevertheless, the analogy is seen as highly useful for timbre production – being embodied rather than just metaphorical, as the shape of the hand and fingers is adjusted.

In the explanations of adjustments of body tension, movement, and positioning of the hand, fingers and body, a strong association was made between the corporeal experience and the sonic outcome. This is in line with theories of action-perception coupling which indicates that sensory-motor associations are formed through systematic and repeated training processes in musical instrument learning (Maes et al., 2014). Based on the reported results, we argue that this notion needs to be extended to include explicit influencing of perception through bodily action.

7.7 Timbre Relevance

The pianists considered timbre to be more than just a physical property of the piano sound, but regarded it as closely related to expressive intentions and the musical creativity of the performer. This can be seen in the arguments for using timbre as an effective tool to communicate with audiences. The concept of piano timbre, therefore, has benefits for the pianists; for example it

relates to lifelong learning process of piano performance and reflects aesthetic and ideological aspects of piano performance.

7.7.1 The communicative aspects of piano timbre

Expressing timbral intentions as a means of communicating with audiences. Pianists in this study regarded timbral intention as a musical communication with their audience (P1, P4, and P5). It was seen as a crucial means of communication when performing music to their listeners; for instance, one participant noted that timbre is 'the most important thing to show the performance properly to an audience' (P4), and, 'the most important variable to value the success of a live concert' (P5), and is also 'ranked as the first consideration in a live concert which comes before technique and the integrity of performance' (P5).

Making listeners feel engaged and emotionally moved. Additionally, expressing timbral intentions in performance helps to create a close relationship with the audience, by enabling the listeners to engage and be moved – and to share a perceived beauty of sound with their audience (P1, P2, P4, P5, and P6). Timbre plays an important role in terms of attracting the listeners' attention: 'Don't let them feel bored.' (P5), and, 'playing from the heart' (P2). Pianists also indicated that good communication through the timbre of a performance can engage non-musicians, even those with no previous knowledge of that piece. The creation of timbral nuances is 'showing the creativity to their audience beyond completing all musical markings' (P1), which in turn improves the process of musical communication.

As P1 explained:

> It's a really important thing in terms of shaping your journey and your audience's journey through a piece, so you explore the journey that keeps your listeners interested because you have to obviously attend audibly for the piece. I think it's important in that sense – in terms of creating a relationship with your audience, because you understand how beautiful the piece is in different sounds so it's about *you* [emphasis added] putting that through.

7.7.2 The aesthetic value of piano timbre

The concept of piano timbre was seen to be part of the artistic and aesthetic value of a performance, as pianists frequently referred to timbre as 'the beauty' and 'the essence' of sounds (P1, P5, and P7), as well as using the word 'good sound' to evaluate a piano performance. The definition of timbre given by ANSI (1973) emphasizes the function of *discriminating* between sounds that are equal in loudness and pitch, whereas Seashore defined timbre as the *quality* of the tone at any given moment (1936). Our results support both timbre definitions, but with a strong emphasis on timbre as quality. Repp's research (1999) indicated that, aesthetically, the most important elements in piano performance are 'tone' and 'touch', even more so than other measurable variables such as timing and dynamics, although the three are interlinked.

7.7.3 Timbre relates to lifelong learning.

Piano timbre relates to lifelong teaching and learning. As P1 mentioned, the learning of piano timbre 'develops by years and has no pin-point'. Even though they understood the challenges of teaching timbre to young students, as there is 'no sense of the meaning of timbre' and that they 'couldn't feel the difference' (P4), pianists still stated that the teaching of piano timbre should start from a young age rather than 'playing for years' just to 'pass the exams' (P2). The solutions suggested by pianists included building up a 'wider range of repertoire' (P1), 'listening to other pianists' sounds' (P4), and the guidance/demonstration from the piano teacher (P3).

7.7.4 Teaching timbre physically works better

Several pianists (P1, P3, and P6), argued that the teaching of piano timbre based on physical sensation works better than theoretical or conceptual learning. For example, P1 said that piano lessons usually focused on technical aspects for a desired sound, and that they worked with 'hand positions, fingers, and bodies'. That is to say, showing or describing the sound with physical actions is more helpful for students than presenting them with vague ideas and concepts. This suggests that piano teachers and educators might reconsider the use of verbal instructions when

teaching timbral concepts. In order to investigate which are the more effective types of verbal instruction in the teaching and learning of piano timbre targets, the third teaching observation study was conducted, and the findings will be revealed in Chapter 9.

7.7.5 Intermediate discussion

Timbre works as an effective means for the performer to communicate expressive intentions to the audience, and pianists regard the expression of timbral intention in a piano performance as a connection with the audience, and they believe that perceived timbral intention in listeners represents and influences their primary impression of the overall performance. In this sense, the production of piano timbre in the performance context is closely associated with expressive and creative intentions of the performer, and also relates to an artistic and aesthetic value of musical experience.

To understand how a pianist uses piano timbre to connect with their audience, is to understand the efforts that the pianist makes in the process of producing timbral nuances and the significance of these efforts to the performer. The concept of piano timbre seems to bring the performer closer to the musical interpretation and expression of the piece, by actively engaging in exploring sound possibilities and demonstrating via bodily movements and techniques. Needless to say, the production of timbral nuances takes a great deal of effort; but what matters for a performer is their desire to present the beauty, creativity, and expression brought about by timbral effects in a music performance. The challenges and efforts in the production of piano timbre as well as the artistic and aesthetic value gained in such process, partly explains the reason why pianists regard piano timbre as the ultimate performance goal.

The view of lifelong learning of piano timbre is interesting in terms of distinct stages in the development of timbre-related concepts: from earlier stages of ‘lack-of-conception’ developing to an advanced stage of realisation of conception (i.e. what it actually means). The acquisition and development of the conception of piano timbre in a pianist’s lifelong engagement with music

would be an interesting topic for future research – one which is under-researched to my current knowledge.

7.8 Conclusion

The first interview study in my thesis explored the conception of piano timbre from the point of view of pianists – a so-called 'first-person' perspective, looking at aspects such as: what it means, how to realise it, and why it matters. Timbre has been interpreted in a holistic manner, being the sum of the various elements of performance, including compositional structure and performance characteristics. Through an interplay with compositional structure, timbre becomes composer and genre specific as well as being unique to individual pianists.

The results revealed that a diversity of modalities were relied upon to conceptualise piano timbre. Aural, visual, and kinesthetic imagery and feedback were employed to define and refine timbral qualities. Analogies were drawn with various other sound sources both in sonic outcome and manner of sound production, including references to orchestral, spoken, and natural sounds. More specifically, when pianists described the production of a particular timbral effect within a musical context, they conceptualised the hand as the articulator, as parallel to the voice. The close association between corporeal experiences and intended and expected sound effects were further revealed. Experiences of weight, tension, relaxation, gravity and motion were related, not only to bodily movements and touch, but also to subjective descriptions of the resulting piano sounds. The mind and the body are closely coupled in the production of piano timbre, in a sense that concepts, sounds, and movements are integrated in a blended manner. Refined timbral performance requires full attention and concentration, and a continued feedback loop between movement, sound, and imagery.

In this context, the instrument – keys, and hammers, become an extension of the performer's physical gestures which, in turn, produce the desired piano tones. Physically speaking,

the piano timbre is affected by control of the hammer movement, speed, and attack noise. Psychologically, the gestural control from the performer's body (tension, weight, and direction) and contact with the finger on the key (delay, acceleration, weight, depth, and angle) is an inseparable part of the experienced tone quality. Take the example of a 'ringing sound'. The piano is a percussive instrument, however, pianists developed specific performance gestures (i.e. falling through, dropping, releasing) to make the sound ringing and sustaining apart from using the pedal. These expressive gestures are intended to transcend the limits and boundaries of the instrument, which in turn may improve the relationship between the performer and the instrument.

Finally, timbre has been seen as a crucial element in connecting with an audience and in quality of performance. Creating a 'right' or 'good' sound was seen as a means to engage and inspire the audience. Some pianists went as far as describing timbre as the essence of piano performance, as it brings beauty and quality to the listening experience. Pianists regard the pursuit and development of timbre-related conceptions and skills as a lifelong learning process.

The following two chapters will show the findings from the perceptual experiment that demonstrated the contribution of vision and sound to the perception of timbre, and the teaching observation study that investigated the significance of timbre targets in piano lessons and the relevant teaching strategies.

Chapter 8: Perceptual Experiment on Timbral Communication: Results and Discussion

8.1 Background

As explained in chapter 6, a perceptual experiment was designed to examine the impact of visual and auditory information on the perception of timbral qualities expressed by different pianists. This study aimed to answer the main research question of 'how is piano timbre communicated?', and the sub-questions of (1) Do pianists communicate timbral intentions to the audience and is the communication reliable? (2) What do listeners perceive in the communication of timbral intention in a piano performance? (3) What is the relevance of the auditory and/or visual component of musical performance?

To repeat the methodology in short (for details see section 6.4), three performers were instructed to play a given piece of music with ten specific timbral qualities. The audio and video recordings were played back to twenty-one pianist-students for them to give judgement on perceived timbres on a unipolar scale respectively. Participants were also required to respond to forced choices on three pairs of figures that represented physical size, shape, and brightness. In order to examine whether pianists could reliably communicate timbre intentions, data analysis mainly focused on the percentage of correct answers, and a three-way ANOVA was used to examine the influence of heard (actual) timbres, audio-visual presentation mode, and pianist/piece on the perceived (evaluated) timbres. The result of non-verbal sensory judgement was analysed to investigate cross-modal associations in piano timbre perception (e.g. physical shape, size, brightness). The principal component analysis was tested to examine whether these were the most representative dimensions that pianists used to map the ten timbral qualities.

8.2 Percent Correct Analysis

Each listener had to give nine scores representing the percent correct answers for the three pianist/pieces, and for the three audio-visual presentation modes (3x 3 = 9). The results of the percent correct answers for each target timbre are summarised in Table 8.1 below.

The percent correct scores was then further divided into an absolute percentage and a relative percentage. For example, in the perception of the dark timbre, only 15.34% of listeners gave the highest ratings for darkness when exposed to an excerpt performed with dark timbre, and the score was even below chance level when seen without presentation of audio (VO: 9.52%). However, using relative percentage correct, the success of communication of darkness is above chance (19.15%): listeners' rating of darkness was relatively high for this particular timbre instruction compared to when asked to perform the same music with a different timbre instruction.

To examine whether each timbre was evaluated above chance level, a one-sample t-test was conducted, in which the test value was 0.1. The values of t, df, and mean score of the one-sample t-test are summarized below (Table 8.1).This analysis showed that the mean values of all variables were significantly higher than the chance level of 10%, which gives a first indication of a reliable communication of the target instruction. Table 8.2 further shows lowest percent correct responses for *Dark, Round,* and *Bright* (dark < round < bright), and highest percent correct responses for *Light, Relaxed,* and *Sharp* (sharp > relaxed > light).

Table 8.1. T-value, p-value, and mean score of absolute percent correct in the one-sample t-test.

Timbres	Mean	t-value	df	p-value
Bright Percent Correct	.23	4.33	187	< .01
Dark Percent Correct	.15	2.03	188	<.05
Dry Percent Correct	.27	5.27	187	< .01

Velvety Percent Correct	.24	4.58	188	< .01
Heavy Percent Correct	.32	6.43	187	< .01
Light Percent Correct	.35	7.17	188	< .01
Relaxed Percent Correct	.35	7.30	188	< .01
Tense Percent Correct	.27	5.25	188	< .01
Round Percent Correct	.19	3.18	187	< .05
Sharp Percent Correct	.40	8.32	188	< .01

It is noteworthy that the relative percent correct answers regarding round timbre and sharp timbre was considerably higher than the absolute percentage. This implies that the performed piece did not sound very round or sharp, but performers were able to change the degree to which those excerpts were perceived as round or sharp. When considering the influence of AV stimuli on absolute/relative percent correct score, tension and relaxation timbre were more likely to be rated as high when visual information was presented – as can be seen by the higher percent correct score in both absolute and relative percentages in the audio-visual and the visual-only condition compared to the audio-only condition. The impact of the AV stimuli on other timbres was more variable for other timbre evaluations, the details of which will be investigated in the next analysis of variance of the timbre ratings.

Table 8.2. Average percentage of listeners' responses indicating a relatively high rating to the target timbre.

Rated timbre	Absolute percentage [8]				Relative percentage [9]			
	Average	AO	AV	VO	**Average**	AO%	AV	VO
Dark	**15.34**	12.70	23.81	9.52	**19.15**	17.49	23.33	17.46

[8] When the rating of the target timbre was higher than ratings of the other nine timbres when the listener was presented with the performance of a target timbre;
[9] When the rating of target timbre was relatively higher for the performance with target timbre than in the other performances of a piece.

Round	**19.15**	13.33	20.63	22.22	**32.98**	28.33	36.51	31.75
Bright	**23.4**	28.57	20.63	21.67	**29.26**	23.81	31.75	31.67
Velvety	**24.34**	23.81	22.22	26.98	**29.63**	26.98	30.16	31.75
Tense	**26.98**	19.05	30.16	31.75	**25.4**	20.63	25.40	30.16
Dry	**27.13**	31.75	26.98	21.67	**23.94**	25.40	22.22	25.00
Heavy	**31.91**	36.67	28.57	30.16	**30.32**	38.33	28.57	25.40
Light	**34.92**	30.16	36.51	38.10	**39.15**	39.68	42.86	34.92
Relaxed	**35.45**	31.75	34.92	39.68	**34.92**	28.57	38.10	38.10
Sharp	**39.68**	47.62	42.86	28.57	**52.38**	61.90	55.56	39.68
Average	**27.83**	27.54	28.73	27.03	**31.71**	31.11	33.45	30.59

8.3 Three-Way Repeated ANOVA

Timbre ratings were entered into ANOVA with repeated measures on three factors: instruction, AV stimuli, and pianist/piece. Table 8.3 below displays the result of the ANOVA for the evaluation of each of the ten timbres. For additional information, I also did *posthoc* tests including Bonferroni corrections for multiple test where significant three-way interactions were reported.

Table 8.3. Three-way repeated measured ANOVA main effects and interactions for listeners' evaluation of ten timbres.

		Evaluation									
Effects		**Brightness**	**Darkness**	**Heaviness**	**Lightness**	**Roundness**	**Sharpness**	**Relaxed**	**Tense**	**Dry**	**Velvety**
Instruction	**F**	**22.88****	3.92	**59.02****	**52.44****	**32.38****	**45.38****	**39.05****	**45.30****	**31.18****	**70.25****
	r	*.77***	*.2*	*.76***	*.73***	*.66***	*.73***	*.66***	*.70***	*.62***	*.79***
	df	(1, 16)	(1, 16)	(1, 19)	(1, 19)	(1, 17)	(1, 17)	(1, 20)	(1, 20)	(1, 19)	(1, 19)
Pianist/	**F**	**11.90****	**31.48****	**73.12****	**57.28****	**6.80***	**10.25****	**8.42****	**12.83****	**8.93****	**17.22****
Piece	*r*	*.43*	*.66***	*.79***	*.75*	*.53**	*.61*	*.30***	*.39***	*.32***	*.48***
	df	(2, 32)	(2, 32)	(2, 38)	(2, 38)	(2, 34)	(2, 34)	(2, 40)	(2, 40)	(1, 19)	(1, 19)
AV stimuli	**F**	.78	**4.32***	**3.81***	.91	**11.56****	**14.75****	.48	1.39	1.02	**4.37***
	r	*.05*	*.21**	*.17**	*.05*	*.64***	*.68***	*.02*	*.07*	*.05*	*.19**
	df	(2, 32)	(2, 32)	(2, 38)	(2, 38)	(2, 34)	(2, 34)	(2, 40)	(2, 40)	(2. 38)	(2. 38)
Instruction	**F**	.93	.86	1.28	**7.96****	**11.31****	**8.21****	**8.11****	3.13	2.85	**3.84***
* Piece	*r*	*.06*	*.05*	*.06*	*.30***	*.63***	*.57***	*.29***	*.14*	*.13*	*.17**
	df	(2, 32)	(2, 32)	(2, 38)	(2, 38)	(2, 34)	(2, 34)	(2, 40)	(2, 40)	(2. 38)	(2. 38)
Instruction *	**F**	.28	.83	.17	.11	.11	1.09	**3.81***	**6.95****	2.29	**3.80***
AV	*r*	*.02*	*.05*	*.01*	*.01*	*.01*	*.06*	*.16**	*.26***	*.11*	*.17**
	df	(2, 32)	(2, 32)	(2, 38)	(2, 38)	(2, 34)	(2, 34)	(2, 40)	(2, 40)	(2. 38)	(2. 38)
Piece *	**F**	1.86	1.36	2.21	.91	2.22	1.55	**3.10***	.53	.62	.41
AV	*r*	*.10*	*.08*	*.10*	*.05*	*.12*	*.08*	*.13**	*.03*	*.03*	*.02*
	df	(4, 64)	(4, 64)	(4, 76)	(4, 76)	(4, 68)	(4, 68)	(4, 80)	(4, 80)	(4, 76)	(4, 76)
Instruction	**F**	.31	1.16	**4.80****	1.20	1.52	**4.04***	1.83	.73	.75	**3.31***
* Piece *	*r*	*.02*	*.07*	*.45***	*.06*	*.08*	*.19**	*.08*	*.04*	*.04*	*.15**
AV	df	(4, 64)	(4, 64)	(4, 76)	(4, 76)	(4, 68)	(4, 68)	(4, 80)	(4, 80)	(4, 76)	(4, 76)

** $p < .01$; * $p < .05$

8.3.1 The evaluation of Bright timbre

There were significant main effects of instruction and pianist/piece on the evaluation of Bright timbre. This means that the Bright timbre was differentiated well across two performances with contrasting instructions. Additionally, some pianists/pieces (P2 & P3) were perceived as brighter than the other (P1). However, there was no significant main effect and no interaction with the factor of AV stimuli, indicating that the performances were evaluated similarly irrespective of the mode of presentation.

This study did not find any two-way or three-way interactions involving the effect of instruction, which indicates that Bright timbre was differentiated well in the two instruction conditions irrespective of the effects of pianist/piece and AV stimuli.

8.3.2 The evaluation of Dark timbre

The main effects of pianist/piece and AV stimuli on the evaluation of Dark timbre were significant. One pianist/piece (P1) was rated as darker than the others (P2 & P3); performances in some AV presentations (both seeing and hearing) were perceived as being darker than in other AV presentations. However, neither main effect nor two-way interactions were significant with the effect of instruction, suggesting that the communication of darkness was not reliable for pianist/piece and AV stimuli.

This study did not find a significant three-way interaction between instruction, pianist/piece, and AV stimuli, but the results of a posthoc contrast showed that the difference was significant between P2 and P3 when comparing AO condition and VO. Figure 8.1 below indicates that P3 differentiated more effectively between darkness and brightness than P2 in a visual-only context.

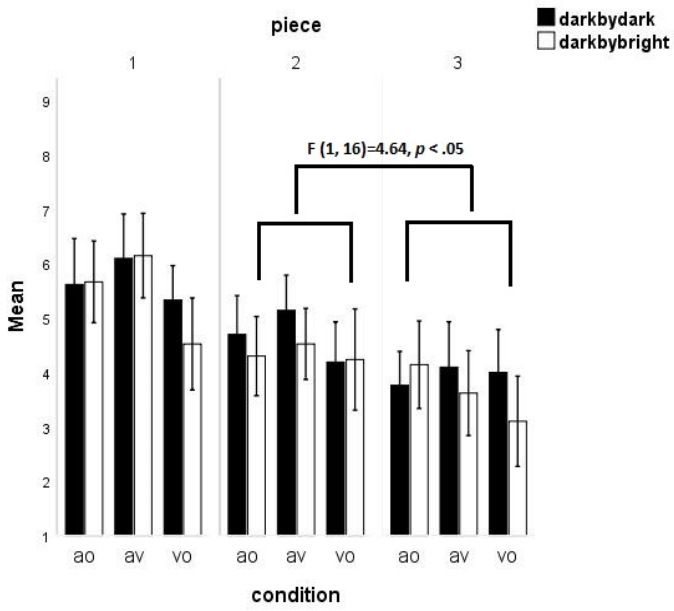


Figure 8.1. Mean values of the evaluation of Dark timbre across three pianists/pieces and AV stimuli. Error lines represent confidence intervals.

8.3.3 The evaluation of Heavy timbre

Significant main effects of instruction, pianist/piece, and AV stimuli were found in the evaluation of Heavy timbre. Heavy timbre was successfully differentiated in two instruction conditions, and P1 was rated as much heavier than the others. The performances were perceived as heavier in AO presentation than in AV presentation.

This study didn't find any two-way interaction with the effect of instruction. However, a significant three-way interaction was found, indicating that heaviness was communicated more reliably by particular pianists/pieces depending on certain AV stimuli. Figure 8.2 below shows that there is a trend in different AV stimuli, P1 communicated Heavy timbre better than P3 in auditory stimuli while P3 communicated better in visual-only stimuli.

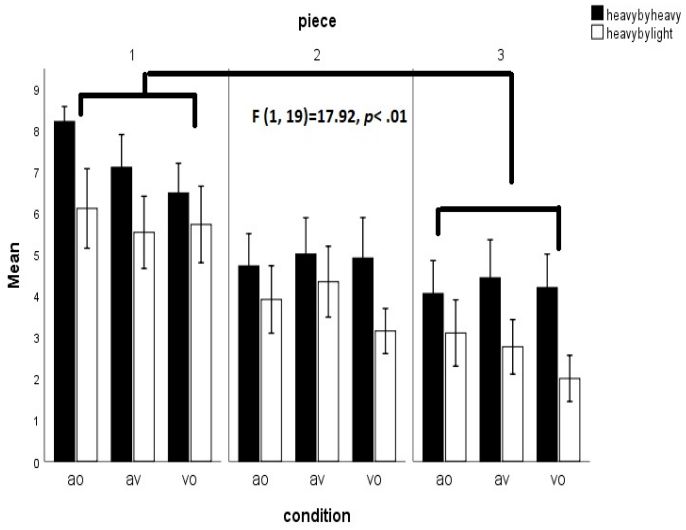


*Figure 8.2***.** Mean values of the evaluation of Heavy timbre across three pianists/pieces and AV stimuli. Error lines represent confidence intervals.

8.3.4 The evaluation of Light timbre

Main effects of instruction and pianist/piece were found for the evaluation of Light timbre. Light timbre was successfully differentiated in two instruction conditions. The performance of P3, was perceived as being lighter than the other two pianists/pieces (P1 & P2). Additionally, significant two-way interaction were found between the effects of instruction and pianist/piece. Light timbre was communicated better in P3.

This study did not find any significant main effects or interaction involving the effect of AV stimuli. To visualise the difference, Figure 8.3 indicates that the difference in lightness evaluation between light and dark instruction is the same irrespective of AV stimuli.

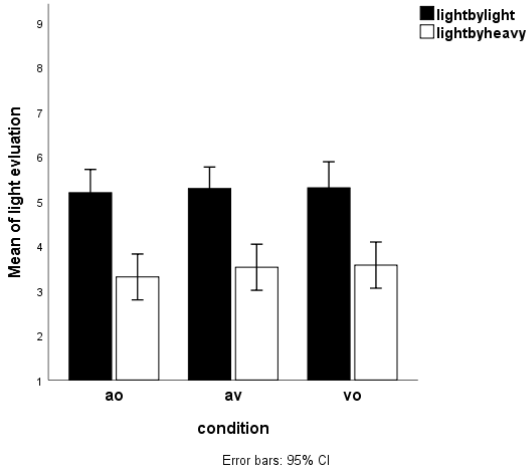


Figure 8.3. Mean values of the evaluation of Light timbre across AV stimuli found by averaging the factor of pianist/piece. Error lines represent confidence intervals.

8.3.5 The evaluation of Round timbre

Significant results were found in relation to the instruction, the pianist/piece, and the AV stimuli. Roundness of timbre was differentiated successfully in the two instruction conditions. One pianist/piece (P3) was rated as being rounder than the other two performances; and the performances were perceived as being rounder in certain AV stimuli (visual-only).

We found a significant two-way interaction between instruction and pianist/piece: the roundness was differentiated more successfully in P3 than P2. Additionally, the two-way interaction between pianist/piece and AV stimuli was also significant. The performance of P3 was perceived as being rounder than P2 in the visual-only context.

8.3.6 The evaluation of Sharp timbre

Significant main effects of instruction, the piece, and AV stimuli were found in the evaluation of sharp timbre. Sharp timbre was successfully differentiated in the two instruction

conditions, and P1 was perceived as being sharper than the other two pianist/pieces. The performances were rated as sharper when listeners could hear the music (AO & AV) instead of only seeing.

A significant three-way interaction was found between the effects of the instruction, the pianist/piece, and AV stimuli for the sharpness evaluation. Figure 8.4 below further indicates that P1 communicated Sharp timbre better in visual-only condition while P3 communicated better in auditory conditions.

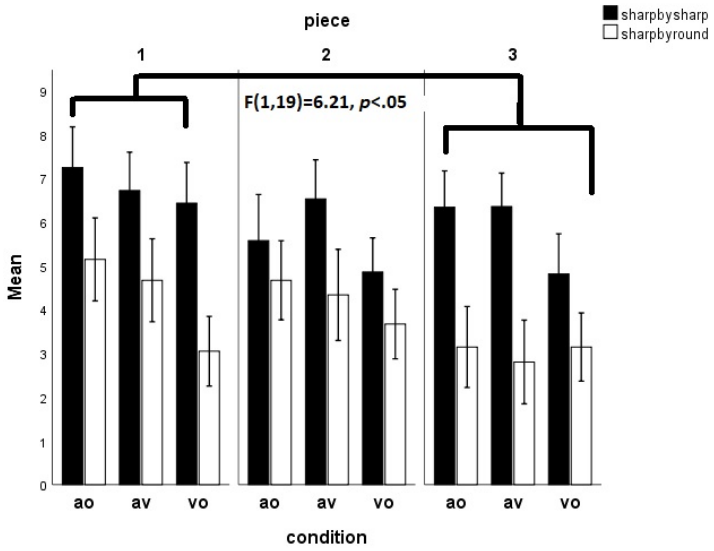


Figure 8.4. Mean values of the evaluation of Sharp timbre across three pianists/pieces and AV stimuli. Error lines represent confidence intervals.

8.3.7 The evaluation of Relaxed timbre

Main effects of instruction and pianist/piece were found in the evaluation of Relaxed timbre. Relaxed timbre was differentiated effectively in the two instruction settings. Both pianist/piece 1 and 3 were rated as more relaxed than P2.

Significant two-way interactions were found between instruction and pianist/piece, and between instruction and AV stimuli. Relaxation was differentiated the least successfully in P2 compared with the other two pianists/pieces; relaxed timbre was communicated better in both

conditions that included visual information than the sound-only condition (see figure 8.5-left). Additionally, two-way interaction were significant between pianist/piece and AV stimuli.

8.3.8 The evaluation of Tense timbre

Significant main effects of instruction and pianist/piece were found in the evaluation of Tense timbre, confirming that all pianists/pieces conveyed a significant contrast between tense timbres in the two instruction settings. Pianist/piece 2 was perceived as communicating more tension than the other two pianists/pieces.

A significant two-way interaction was found between the effects of instruction and AV stimuli. Figure 8.5-right below shows that tension was differentiated more clearly in visual-only condition than in the audio-only condition.

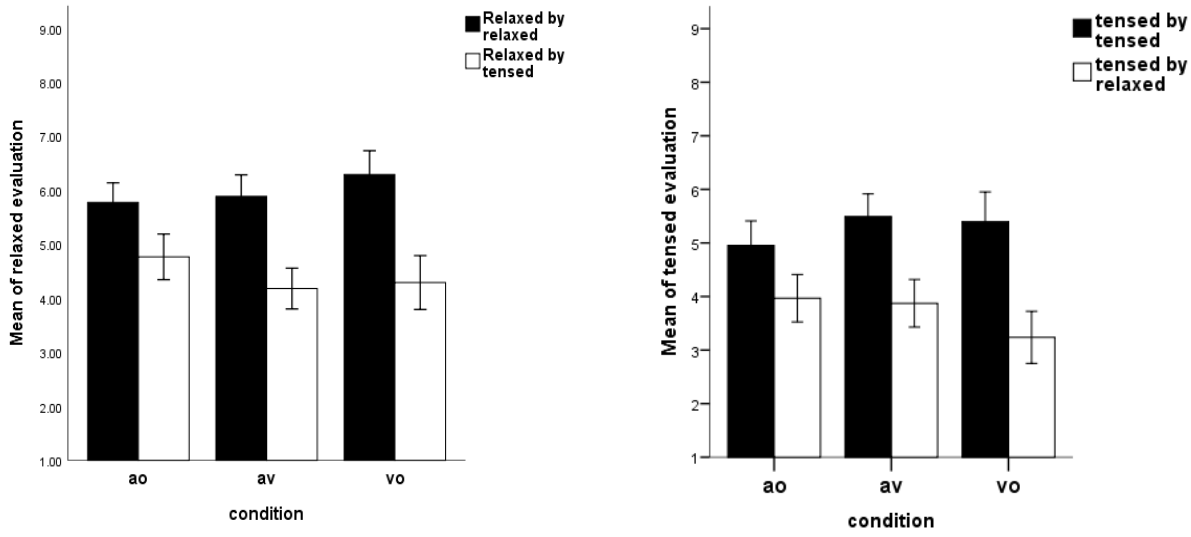


Figure 8.5. Mean values of the evaluation of Relaxed timbre (left) and Tense timbre (right) across three AV stimuli found by averaging the factor of the pianist/piece. Error bars represent confidence intervals.

8.3.9 The evaluation of Dry timbre

Significant main effects of instruction and pianist/piece were found in the evaluation of Dry timbre. This indicates that Dry timbre was successfully differentiated with velvety timbre in the two instruction conditions. Furthermore, the timbre of P2 was perceived as being much dryer than the other two performances (P1 & P3). However, there was no significant main effect and no interactions with the effect of AV stimuli, which means that the differentiation of dry timbre was successful in the two instruction settings but was independent of the mode of audio-visual presentation.

8.3.10 The evaluation of Velvety timbre

Significant main effects of instruction, pianist/piece, and AV stimuli were found in the evaluation of Velvety timbre. All pianists/pieces differentiated Velvety timbre successfully in the two instruction conditions. Additionally, P1 and P3 were perceived as more velvety than P2. Additionally, performances presented in a visual-only context were rated as much more velvety.

Significant two-way interactions were found between the effects of instruction and pianist/piece, and between instruction and AV stimuli. Velvety timbre was differentiated better by instruction for P1; the contrast was furthermore larger in the audio-only context.

The three-way interaction between the effects of instruction, pianist/piece, and AV stimuli were also significant. Figure 8.6 below shows that P1 communicated Velvety timbre more effectively in auditory stimuli than P2 was better in visual-only stimuli.

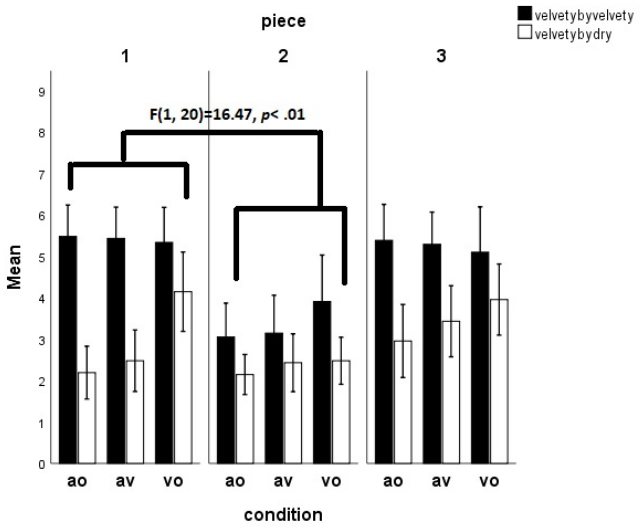


Figure 8.6. Mean value of the evaluation of Velvety timbre across three pianists/pieces and AV stimuli. Error lines represent confidence intervals.

8.4 Principal Components Analysis (PCA)

Before conducting the PCA, pairwise Pearson correlations were examined between the ten variables. None of the scores in the correlation matrix were higher than 0.9, which indicates that no pair of variables seems to be measuring the same thing, meaning that none of the ten variables needed to be excluded before running the analysis.

The PCA revealed the presence of three components with eigenvalues greater than 1, which account for a total of 69.6% of the variance in evaluations of the ten timbres, explaining 38.71%, 19.2%, and 11.68% of the variance respectively.

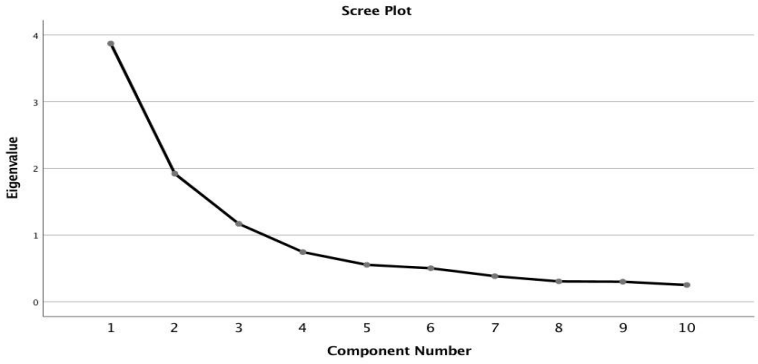


Figure 8.7. Screen plot of ten variables in the principle component analysis.

To aid the interpretation of the three components, varimax rotation was used and the results are displayed in Table 8.3. Loading values that were less than 0.3 were excluded from the table, so there are blanks in the table where low loading exists. Three clusters which spread across three component dimensions are clearly observed as indicated in the table (every cluster is highlighted in red). The next objective of the PCA was to see if the items that have high loadings on each factor can fit together conceptually and can be named (Leech, Barrett, & Borgan, 2008). A few items relate to just one dimension (e.g. round and velvety in dimension one; bright in dimension three). Others load to more than one dimension. These will be allocated to one particular component based on their relative loading. For example, tense and sharp in the first dimension were negative, but became positive and had greater loading scores in the second dimension. As a result, relaxed is interpreted in the first dimension, tense and sharp are interpreted in the second component, while light is interpreted in the third dimension.

Table 8.3. Factor loading after varimax rotation.

Evaluation	Component 1 Round (Touch-movement)	Component 2 Heavy (Weight-Negative intensity)	Component 3 Bright (Luminance)
Round	**.851**		
Velvety	**.827**		
Dry	-.626	.333	.340
Relaxed	.595		.486
Heavy		**.811**	-.328
Dark		**.765**	-.320
Tense	-.473	.650	
Sharp	-.595	.614	
Bright			**.829**
Light		-.344	**.744**

The items that cluster on the same components suggest that the first dimension (eigenvalue: 38.7%) includes the timbre evaluation of round, velvety, relaxed (positive scores) and non-dry (negative score). This dimension is related to touch and movement qualities and is most strongly associated with Round. It is a combination of tactile feelings of roundness and velvetiness, and low dryness. The second component relates to the evaluation of heavy, dark, tense and sharp. This is a combination of high intensity and negative valence, and is associated with haptic sensations of sharpness and tactile sensations of heaviness. It is most strongly associated with Heavy and relates to experiences of weight and negative intensity. The last component is most strongly associated with Brightness followed by lightness. It seems associated with luminance, which is both positive in valence, high in space and lightweight. The reasons for labelling and judgement categorisation will be discussed further in Section 8.7.3.

8.5 Non-Verbal Sensory Judgement Analysis

Judgement of the size, shape, and brightness was collected as categorical data in the form of either: A (bigger size, rounder shape, brighter version), or B (smaller size, sharper shape, darker version) in the questionnaire. This data was replaced with a score of either 0 or 1, to give a method of calculating the mean across different participants (N = 21). The measure of each type of judgement (e.g. size evaluation while hearing bright timbre) for each participant was calculated via an average across AV stimuli and three music pieces (Mean = SUM divided by 9). The value of each type of judgement on hearing different timbre intentions is displayed in Table 8.4 below.

A paired sample T-test was conducted to compare the mean values of each type of judgement within a pair of timbre with contrasting intentions; for instance, the mean difference in size evaluation between hearing bright timbre and hearing dark timbre.

Table 8.4. Mean judgement scores for size, shape, and brightness when hearing the following ten timbres. Significant mean differences within a pair are highlighted in the table.

	Size	**Shape**	**Brightness**
	(big) 0 -- 1 (small)	(round) 0 -- 1 (sharp)	(bright) 0 -- 1 (dark)
Bright	.53*	.55**	.47
Dark	.65*	.38**	.43
Round	.51	.34**	.46
Sharp	.41	.83**	.56
Heavy	.42**	.59**	.47
Light	.69**	.28**	.40
Tense	.59	.60**	.52*
Relaxed	.62	.32**	.37*
Dry	.61	.62**	.46
Velvety	.54	.24**	.43

*** p < .01; * p < .05*

The results indicated that there is a strong association between timbre production and shape evaluation in all five pairs of timbre intentions (middle column). In contrast, size was only differentially associated with performances contrasting in the instruction to play bright or dark or to play heavy or light, while the choice of objects differing in brightness was only influenced by contrasting instructions related to tension-relaxation.

The pattern of association was as expected: the round object was chosen when hearing/seeing performances with bright, round, light, relaxed, and velvety timbral intentions, while a sharp shape while was chosen when hearing/seeing performances with dark, sharp, heavy, tense, and dry timbral intentions. Furthermore, small size was associated with dark as well as lightweight performances, whilst big size was associated with heavy and bright performances. The association with visual brightness was poor and was only found when hearing either tense (dark)

or relaxed (bright) performances. The relevance of cross-modal correspondence experience in musical listening will be discussed in Section 8.7.5.

8.6 A comparison of performance characteristics

The five figures below display the audio waves of each timbre played by three pianists, which provides an overall impression of performance duration and intensity. In general, P1 and P3 showed greater contrast in performance intensity and tempo than P2 to differentiate a pair of timbre. Specifically, these figures indicate for each timbre the following differences in performance characteristics.

- Bright-Dark timbre: For P1 and P3, bright timbre was louder while dark timbre was softer. P2 did not change the performance intensity as much, but played dark timbre much slower.
- Heavy-Light timbre: For the three pianists, heavy timbre was played louder than light timbre (the difference was exaggerated in P1 and P3). P1 interpreted light timbre as slower while P3 did the opposite way.
- Relaxed-Tense timbre: For P1 and P3, tense timbre was played louder than relaxed timbre.
- Round-Sharp timbre: For P1 and P3, sharp timbre was played louder and quicker than round timbre.
- Dry-Velvety timbre: Only for P1, dry timbre was louder than velvety, but P2 performed dry timbre quicker than velvety.

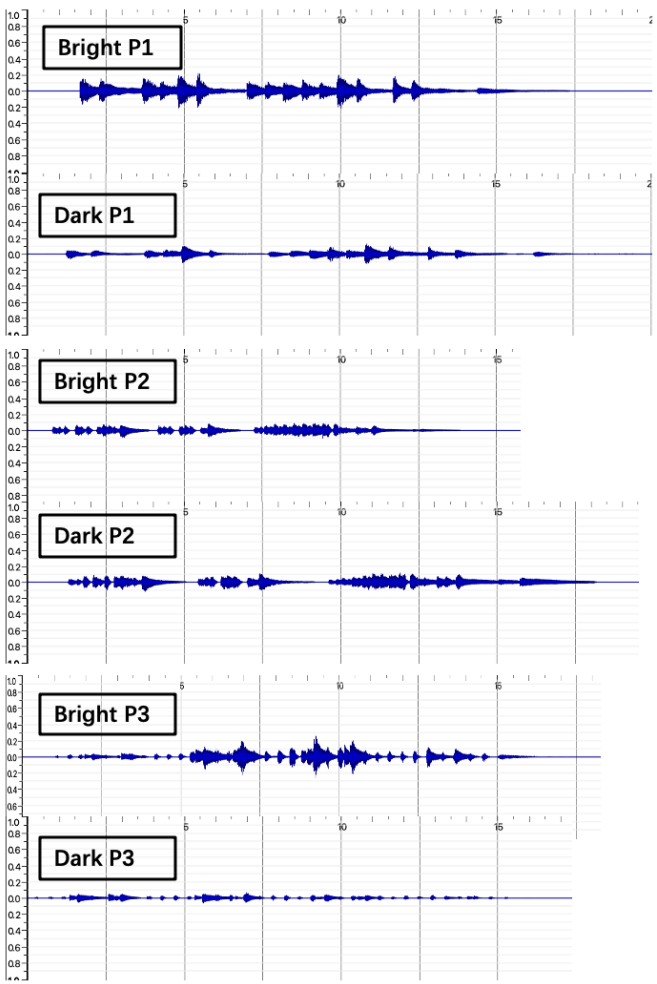


Figure 8.8 (A): the audio wave of the performances of BRIGHT and DARK timbre of Pianist 1, 2, and 3.

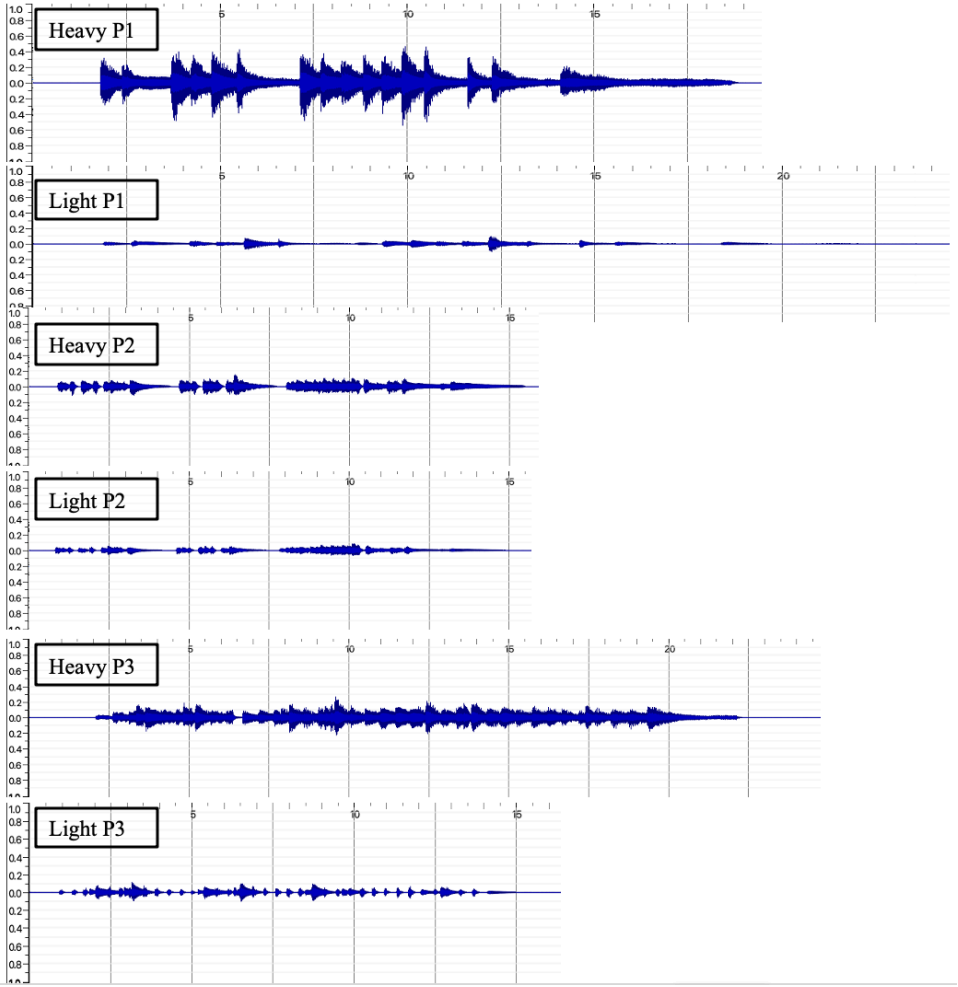


Figure 8.8 (B): the audio wave of the performances of HEAVY and LIGHT timbre of pianist 1, 2, and 3.

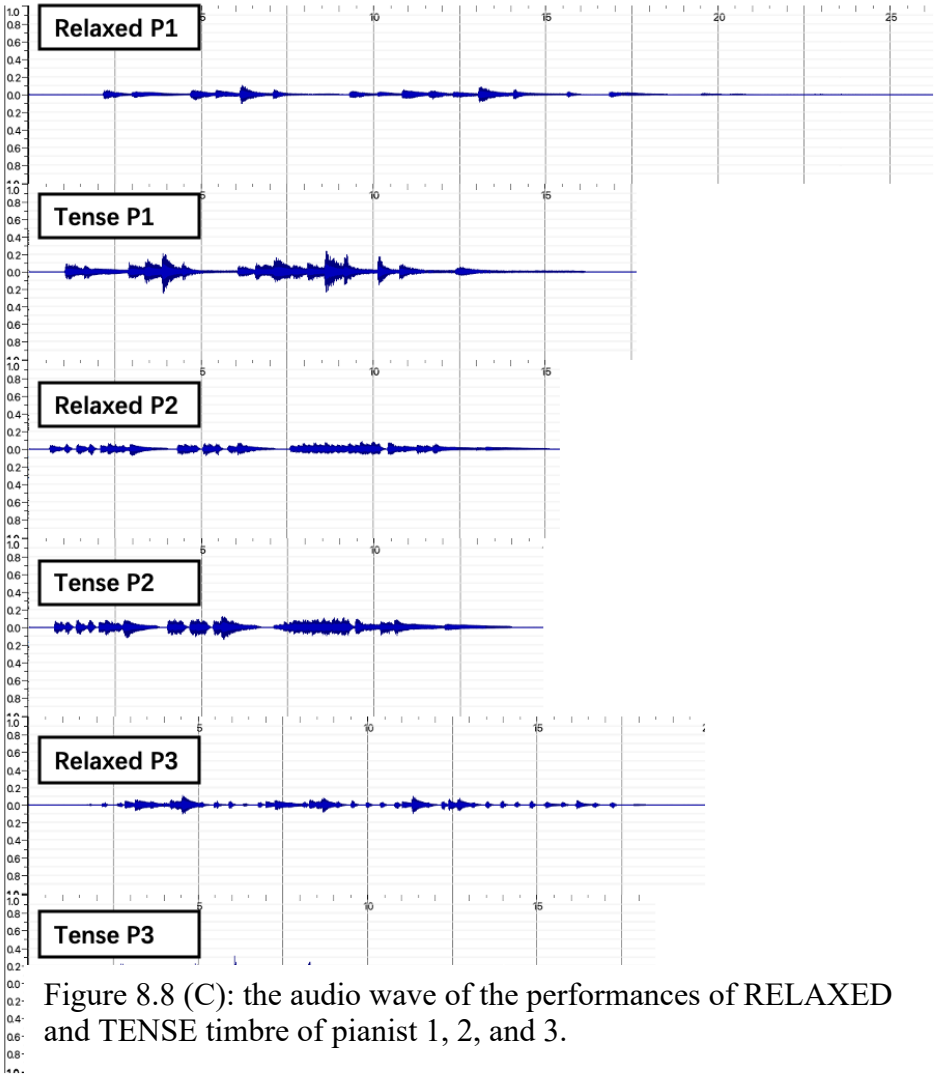


Figure 8.8 (C): the audio wave of the performances of RELAXED and TENSE timbre of pianist 1, 2, and 3.

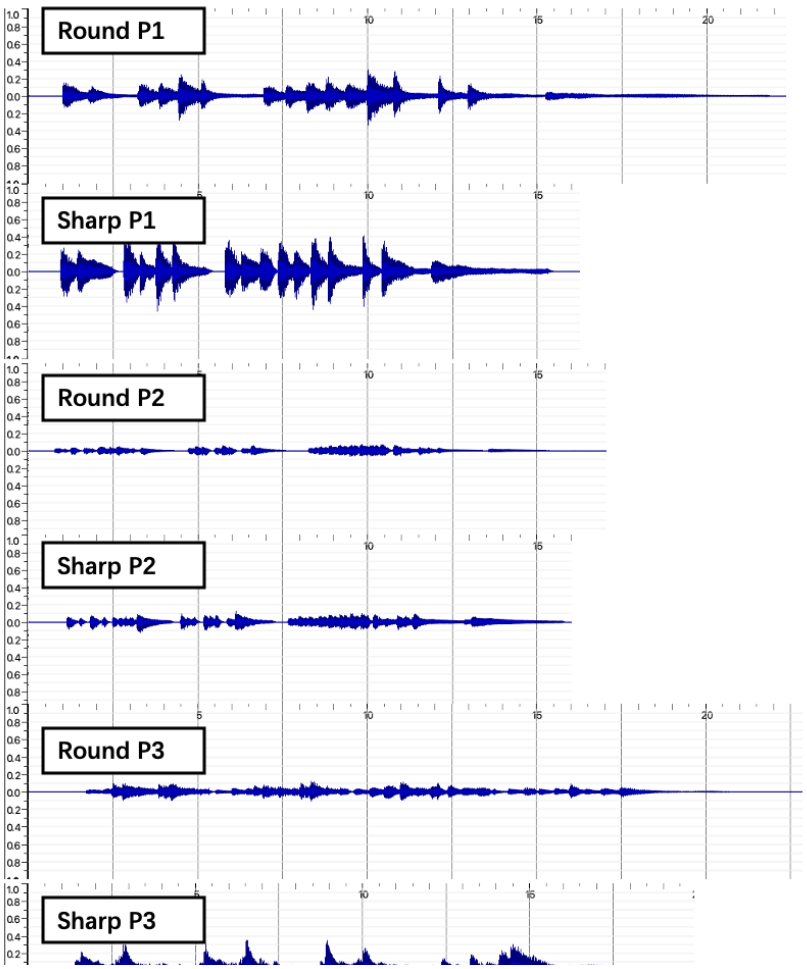


Figure 8.8 (D): the audio wave of the performances of ROUND and SHARP timbre of pianist 1, 2, and 3.

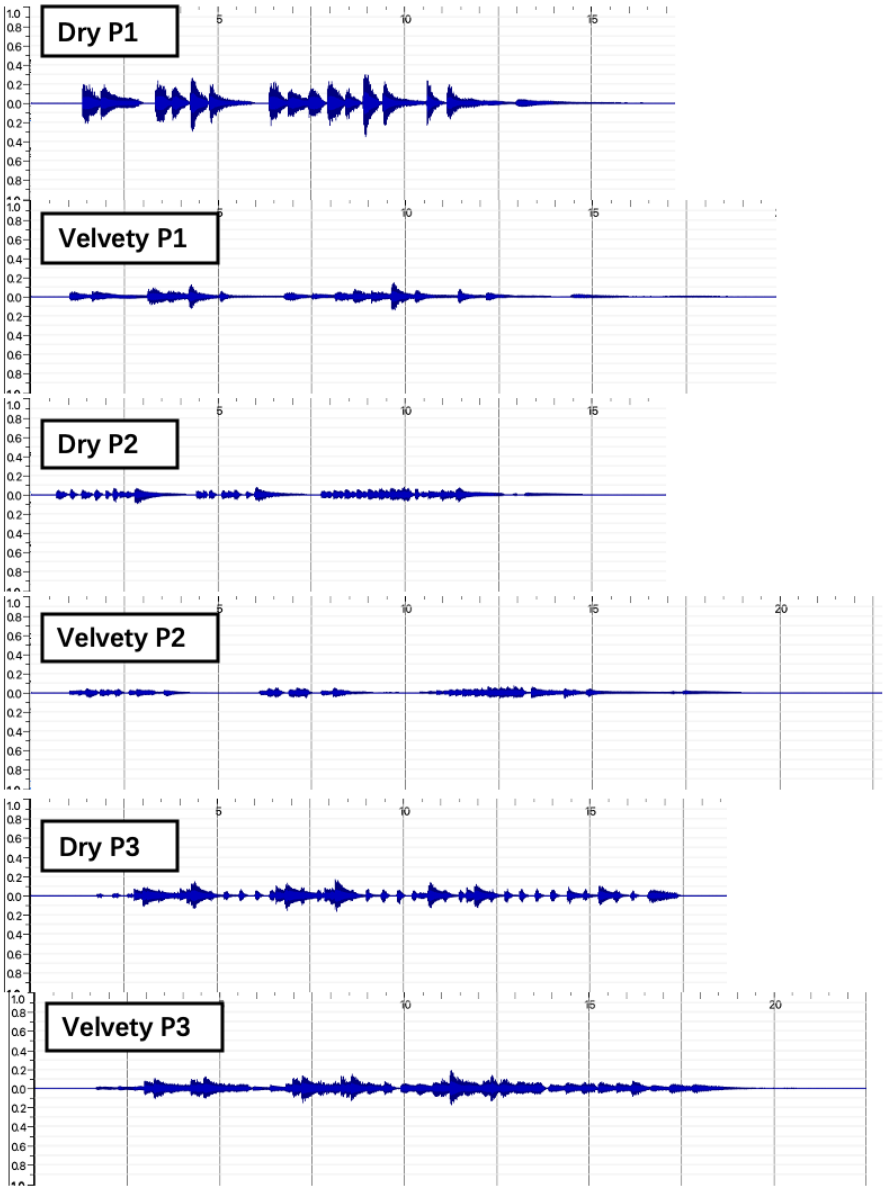


Figure 8.8 (E): the audio wave of the performances of DRY and VELVETY timbre of pianist 1, 2, and 3.

8.7 Discussion

8.7.1 Overall perception of the ten timbral intentions

Brightness dimension: bright-dark timbre. The brightness dimension of piano timbre was the least well communicated of the five pairs of timbres in this study, in particular for dark timbre. More specifically, the communication of bright timbre was successful independent of the pianist/piece and AV stimuli; whilst for the dark timbre, the three performers were unable to make contrasting performances in the two instruction conditions and the listeners were unable to differentiate dark timbre successfully in their responses. The percent correct score for the recognition of darkness was the lowest. Furthermore, the PCA results suggested that bright timbre was strongly correlated with light timbre, while dark timbre was strongly correlated with heavy timbre, which may influence the judgment of the brightness dimension.

For string instruments, different bowing or plucking positions nearer the bridge (for a darker sound) or the soundboard (for a brighter sound) may change the timbral brightness effectively under the condition of keeping the intensity and pitch constant (Traube, 2006; Chudy, Carrillo, & Dixon, 2013). However, a pianist is unable to make such a significant change in sound-producing positions, but has to rely on other technical manners. Another reason for unsuccessful communication may be that there is no shared consensus of pianists in using intensity, articulation and tempo to communicate brightness. For example, Pianist 1 and 3 interpreted bright timbre as louder than dark timbres; in contrast, Pianist 2 did not significantly change the performed intensity but played faster with bright timbre and slower with dark timbre (Figure 8.8-A). This is consistent with the study of Bernays and Traube (2014) which showed pianists' individuality in the employment of either high or low intensity as well as in attack speed to differentiate bright and dark timbre. The results of this study have implied the difficulties in the communication of dark timbre using audio-only, but visual information helps listeners to differentiate the intentions from certain degree (Figure 8.9, contrasting facial expressions or body postures). Music teachers may

take the individuality into consideration and rely on multimodality (visual, kinaesthetic, emotional) to help students understand the timbral brightness in addition to the sound demonstration.

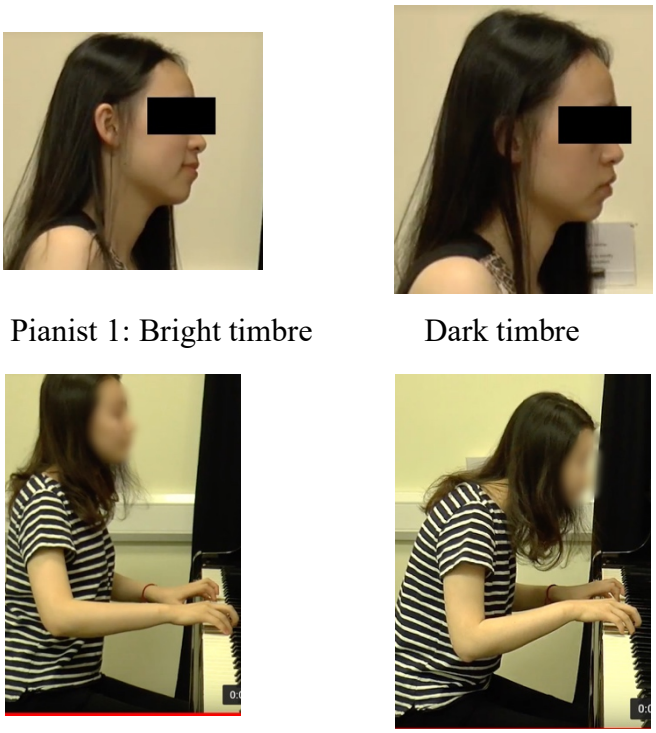


Figure 8.9. The facial expression and posture of two performers when expressing bright and dark timbres

Lightness dimension: Heavy and light timbre. The communication of timbral heaviness/lightness was successful, and was not strongly dependent on the factor of AV stimuli but dependent on the pianists/pieces. Most specifically, pianist/piece 1 and pianist/piece 3 relied differently on audio or visual aids to communicate Heavy timbre (P1 is better in sounds while P3 is better in visions). The PCA results have implied a strong association between timbral lightness and brightness: lighter is brighter, while heavier is darker.

In relation to other performance parameters, the study of Canazza, De Poli, Rodà, and Vidolin (2003) have shown that performers vary the performance tempo in accordance with the expressive intentions of either heavy or light (i.e. heavy is slower while light is faster). In contrast,

this study found that the heavy-slow and light-fast association was only present in P1's performance but not for P2 (no difference in performance tempo) and P3 (who did the opposite). Instead, all pianists played louder in the expression of heavy timbre than light timbre (Figure 8.8-B). This is part of the reasons that lightness was closely associated with brightness in the perception of piano timbre in this study. This study assumes that neither performance tempo nor intensity were the only performance parameter that the pianists relied on to communicate heavy/light timbre; they will utilise more subtle variances (e.g. attack speed, key depression depth, or key release speed) to differentiate the heaviness/lightness of piano timbre. Furthermore, the successful communication of lightness-dimension of piano timbre revealed the well-known relationship of music and motion in music perception (cf. Clarke, 2001; Eitan & Granot, 2006). The timbre of piano tones tended to communicate kinetic- or energy-related qualities to the listeners that differed in either in momentum or weight; and listeners associated piano timbre with certain motional features in virtual spaces: heavy timbre was perceived as physical objects that have more weights; while light timbre as having less weight.

Relaxation dimension: relaxed and tense timbre. The communication of relaxation-dimension of piano timbre was successful and highly dependent on the visual component of the piano performances. Both relaxed and tense timbres were communicated with more reliability when performances included visual information; tension was communicated even better in a visual-only context (without sounds). The pairing of tension and relaxation is a special case in the ten timbre evaluations, in that they have both a relative and absolute percent correct score in the visual-only condition, that was even higher than both audio conditions.

The success of communicating in a visual-only condition can be explained by the mechanism of mirror neuron system and sensory-motor association. As mentioned in Chapter 5, the muscular tension/relaxation has become a regular part of the sensory-motor repertoire as a result of piano practice and learning, and it is well established in the performer's motor system.

Similar neuron activities are found in humans when planning the actions and observing the actions (Gallese et al., 1996); and auditory and motor systems in the brain will be co-activated in pianists when asked to play a silent piano or when perceiving musical performances (Maes et al., 2013). Therefore, the observed performance action in another pianist's silent playing seems to be strong enough to trigger the motor planning system and generate similar sensory outcomes – bodily relaxation and tension in this study. As a result, tension and relaxation are felt when seeing another pianist playing, even in a silent condition. Although this study failed to test the difference in perceived tension and relaxation between musicians and non-musicians, I have assumed that there will not be significant difference. The striking action required to play a piano is very similar to other types of everyday behaviour to a certain degree, such as typing on a keyboard. The kinaesthetic experience that humans learn from everyday physical movement can help them to understand performance actions in piano playing. Similarly, we can easily tell whether an actor is relaxed or tense when we are watching a TV programme even though we do not have equivalent knowledge of acting or performing. In this sense, non-pianists can detect the relaxation and tension information from the visual presentation of a piano performance.

Roundness-dimension: round and sharp timbre. The communication of the roundness-dimension of piano timbre was reliable and successful. The repeated measured ANOVA results indicate a high dependence on the pianists/pieces. Interesting, the communication of timbral roundness/sharpness was not strongly related to the factor of AV stimuli, except that P1 used the visual information better than P3 in particular for sharp timbre.

The successful communication of the roundness of piano timbre implied the influence of sound-producing actions on listener's mental imagery of produced timbre (cf. Leman & Godøy (2010) -- in this study, mental imagery of piano timbre relates to the physical shape (i.e. roundness and sharpness). Sound-producing actions to vary the sharpness/roundness of timbre may differ in terms of utilising either hard or soft touch (Halmilton, 2012), larger or smaller contact size

(Ortmann, 1935), and percussive or non-percussive striking (Parncutt & Troup, 2002). For example, Ortmann (1935) stated that round timbres are produced by a gradual increase of pressure on the key, while sharp timbres are related to smaller-skin area the touch qualities differ in producing round and sharp timbre; Hamilton (2012) mentioned the sharper piano tones result from striking the key violently and a softer tone would generate by pressing the key gently. The dependence on pianists/pieces in the communication of round and sharp timbre may reflect differences in pianists' technical control of the production of piano timbre. The differences in the musical pieces may also cause the differences in perceived roundness of piano timbre, for instance the range of pitch (e.g. high pitched piano tones are hard to be rich and round) or the average intensity (e.g. mid-range of dynamics are more likely to be round) of the musical piece (Ortmann, 1935).

Texture[5] *dimension: dry and velvety timbre.* Both dry and velvety timbre were successfully communicated, but they have indicated different reliance on AV presentation modes and pianists/pieces. Dry timbre was reliably communicated independently of these two factors, while the communication of velvety timbre was highly dependent on both of them. The contrasting results may be because the pairing of dry and velvety was the least contrasting pair in the five pairs of timbral intentions in this study. However, this pairing of timbres represents the texture-dimension of piano timbre. The successful communication of this dimension implied that the pianists were able to communicate relatively subtle features of timbral qualities apart from brightness, lightness, and shape. Referring back to the differences in embodied musical learning and everyday-context learning (section 3.2.1), the results suggested that the interaction between the performer and the instrument offers more dynamic and subtle sensorimotor experience to the performers,.

[5] Here texture refers to a tactile feeling of the surface of an object, rather than "musical texture" (monophonic, polyphonic etc.).

8.7.2 Influence of performers and AV stimuli

The results of two-way interaction between instruction and piece suggested that pieces/pianists differ from each other in their capacities to communicate different timbres. For instance, P3 was much more successful in communicating timbres that included lightness and roundness; P1 was able to communicate timbres like dryness and velvetyness more effectively; and in addition, P1 and P3 had similar success in communicating sharpness and relaxation, unlike P2 who was less successful.

Apart from the pairing of tense-relax timbres, where visual information determined the effectiveness of timbral communication independent of the pianist/piece, the influence of AV stimuli was accompanied with an interaction involving the effect of pianist/piece in most cases, as shown in the results of three-way interaction. For example: heaviness was communicated better by P1 with sound, while P3 communicated more effectively with visual information; sharpness was communicated more successfully by P1 with visual information only, while P3 had a higher rate of success with sound. This indicates that there is no one effective communication channel, but that the success of audio or visual information depends on the pianist and piece, as well as the particular timbre instruction.

The individual differences between performers in communicating expressive intention has not been a major concern in previous empirical studies. Rather, the majority of perceptual studies on visual communication of performance have only used one performer as the experiment stimuli, for instance: the utilisation of a solo pianist (Davidson, 1993; Vuoskoski et al., 2014), a solo singer (Davidson, 2001), a solo marimba player (Schutz & Lipscomb, 2007), and solo saxophone and bassoon players (Dahl & Friberg, 2007). These studies are not able to explain why some performers move less but are still capable of creating extraordinary, expressive performances (e.g. Vladimir Horowitz), and other performers make exaggerated movements to create effects (e.g.

Lang Lang). While it is acknowledged that using multiple performances as well as sound/video stimuli in this perceptual experiment has caused some difficulties in generating stimuli and data analysis, this study has suggested that the visual communication of timbral intentions is usually interlinked with the factor of the pianist/piece. The ability of the pianist to communicate timbre differs not according to skill level, but, rather, is reliant on different modes (i.e. some are better in sound, and others communicate visually).

The individual differences in employing visual benefits in musical communication raises another interesting topic: since some performers are already very good at communicating through sound, maybe it is necessary for them to learn more about visual communication in performance. I would suggest several reasons why musicians need to embrace the visual impact of their performances: the main reason is that visual information helps to overcome the fact of the limited timbral nuances available on the piano, and therefore adds extra 'flavours' and 'dimensions' to the audience's auditory experience. This study has shown that facial expression works effectively to express bright/dark timbres; also, that the visual presence of the pianist makes tense and relaxed performance even more evident than in a sound-only mode. Maybe there is something here to suggest that teachers should instruct their students to move in certain ways and adopt certain postures or gestures – aiming for better expressive communication.

The visual information in this study also contains a focus on finger movements. This study acknowledges that these movements are related to the sound-producing process and are highly constrained by playing techniques that are hard to vary; however, I will argue that musicians should be aware that this visual information can communicate the timbral intention more richly and accurately, and is likely to have a 'mirroring effect' for the audience who will simulate the sound-producing action in the head when presenting to the visual stimuli. The successful communication

of several timbres in visual-only stimuli has already demonstrated that same concepts are being evoked by sound-producing gestures.

When considering bodily movements in music performance from a broad dimension (e.g. torso and head movements), pianists' movements can be viewed as the bodily responses of themselves experiencing music in a first-person perspective. The backward/forward movements and facial expressions correspond to the felt emotional valence and intensity while playing the music – therefore performers are also listeners when producing timbres in this circumstance. When looking at specific bodily movements – fingers, wrists, and arms – this visual information tends to have a mirroring effect on listeners, evoke similar sensorimotor experiences as to those that the performer may be experiencing; therefore listeners can also be performers when perceiving timbre in a piano performance. The visual aspect of piano performance helps to integrate the performer with the listener and enables them to have a shared experience of the perception and production of piano timbre.

8.7.3 Cross-modal association experience with piano timbre

The adjective rating scales were designed to investigate the relationship between sensory perception, emotions, interoceptive feelings, and musical stimuli. Ten timbre descriptors were based on multiple modalities, for instance: haptic (round-sharp, dry-velvety); tactile (heavy-light); interoceptive (relaxed-tense); and, affective/visual (bright-dark).

The PCA results suggested three dimensions within which pianists made judgements of perceived timbral features. The first, the Round-dimension, is closely related to positive touch qualities that represent the cluster of velvety, round, relaxed, and less-dry timbres. We can easily find evidence of this association between such descriptors and finger touch in the pianists' discourses. Liszt, describing his first impression of the pianist, Henselt's performance, praised the 'extraordinary velvet tone' (Neuhaus, 1993). Tobias Matthay (1932) mentioned the creation of

sharp timbre by employing less controlled and tense bodily movements: a sharp arm movement causes a solid and rigid chord whose sound will 'kill' the music, while a relaxed elbow and forearm will play a chord that clears out the nasty noise. Russian pianist Josef Lhévinne (1972) advises us to 'see that the key is touched with as resilient a portion of the finger as possible if a lovely, ringing, singing tone is desired instead of the hard, metallic one' (p. 18). More recently in a scientific study, Parncutt and Troup (2002) discussed the aspect of percussive noise in the production of piano timbre and stated that: 'if the amount of noise increases, we hear the sound as increasingly harsh, dry, ugly, or forced' (p.291). This statement implies that a finer control of the percussive noise by a pianist can produce an opposite sound outcome, which is less harsh (therefore round), less dry, more cantabile, and less forced (i.e. relaxed). To conclude, sounds that are rounder, velvety, less dry, and relaxed tend to be more positively evaluated and preferred in pianists; sounds that are tensed and sharper are negatively evaluated and tend to be controlled or avoided. A finer motor control of the percussive noise (key-finger, or key-keybed) is seen as important for pianists in the production of piano tone.

Secondly, the Heavy-dimension includes perceptions of heavy, dark, tense, and sharp timbres. This dimension represents a negative side of touch quality and bodily movements (e.g. tense, sharp timbres relate to less-refined finger control). The significant difference with the Round-dimension, however, is the involvement of heavy and dark perceptions, which are associated with a kinaesthetic experience of heaviness, tension, and emotional intensity. The third component relates to the Sensory-dimension and is associated with perceptions of brightness and lightness. This dimension tends to be more closely associated with visual luminance compared to the first and second dimensions.

A cross-modal timbre-shape association was found in all ten timbres, as suggested by the analysis of non-verbal sensory judgement. When music was played with darker, rounder, lighter, relaxed, and velvety timbral intentions, it was felt to be 'rounder' than when played with brighter,

sharper, heavier, tenser, and drier intentions. This timbre-shape association is in line with several previous studies which have found a sharpness/colour association with either soft or harsh timbres (Adeli et al., 2014) as well as visual textural associations (Giannakis, 2006). In addition to a timbre-shape association, this study also found a timbre-size association when music was played with either a bright or dark timbre, as well as either heavy or light timbre.

Unfortunately, no theoretical explanation has been found to explain the origin of timbre-related cross-modal correspondence. The underlying reasoning for CMC, as it relates to piano timbre production and perception, seems to be mainly resulting from statistical, semantic-mediated, and embodied accounts. Statistical and embodied accounts have explained the results of repeated exposure to and physical interaction with instruments, and the extent to which the weak synaesthesia experience related to piano timbre can be established as a part of musical training. Studies have indicated that repeated exposure to statistical co-current pairs of stimuli can help to shape the coupling pairs, even in circumstances where the stimulus is unrelated. For example, Ernst (2007), observed that repeated exposure to visual luminance together with a feeling of stiffness resulted in an association between these experiences in participants who had not experienced these connections before. Semantic-mediated accounts help in understanding the role of linguistic terms used to understand and describe piano sounds, and their possible impact in generating a cross-modal coupling experience. The study conducted by Dolscheid, Shayan, Majid, and Casasanto (2013) confirmed that the association between musical pitch and physical thickness can be generated in Dutch speakers (who originally experience high-low associations with pitch) after twenty minutes of online language training.

In general, playing the piano results in significant motor-auditory experiences in pianists, and certain cross-modal associations can be established as a result of long-term exposure to motor-auditory associated activities. Timbre-featured CMC experiences include auditory-visual associations (e.g. visual shapes and brightness) and auditory-tactile associations (e.g. heaviness

and lightness). These experiences are reinforced not only in the physical production process, but also in an educational context where language plays a crucial role in understanding and connecting the multiple sensory experiences. For example, in the production of a round timbre, a teacher's feedback and evaluation (good or not, right or wrong) on the hand shape and played sound helps the student to establish an association between the sound outcome and the visual aspect of hand shape, hence generating a visual image that is associated with round timbre.

We describe the perceived qualities of tone in a piano performance by referring to everyday situations. This occurs, for instance, in teacher-student dialogue in piano lessons, the comments of musical critics regarding a piano concert, and music-related prose and poetry. These cross-modal associations of piano timbre afford us a better understanding of the utilisation of timbre descriptors. Timmers and Eitan's study (2012) has shown that pitch-related metaphors vary from explicit and common categories (e.g. high-low, bright-dark, sharp-heavy), to more implicit and abstract domains (e.g. feminine-masculine, young-old, summer-winter). Piano timbre descriptors are similar to those of musical pitch; we seldom describe piano timbre by a singular term, but rather a cluster of descriptors and metaphors that have a consistent and similar meaning. For example; brassy, bright, clear, and shimmering belong to one cluster, while dark, distant, and muddled belong to the opposite cluster (Bernays & Traube, 2011). With respect to the reasoning of the clustering of timbre descriptors, acoustic findings have demonstrated the similarities in sound features (Bernays & Traube, 2011); this study implied that the coherence may arise from the embodiment, that the similarities in the haptic, kinaesthetic, auditory, and visual experience work as a basis to group a set of timbre descriptors. The high correlation between several descriptors in the results of this study have suggested coherent attributes in conceptual structure through which pianists tend to conceptualise piano timbre features.

8.7.4 Contributions, limitations, and future research

One significant aspect of this study is the examination of piano timbre perception using audio-video recordings of pianists' performances rather than artificial experiment stimuli. This is distinct from previous literature which has been concerned with the perception of piano timbre via the manipulation of a singular piano tone. It is acknowledged that previous acoustic studies have demonstrated the influence of specific touch types (e.g. attack noise, Goebl et al., 2014; soft-hard touch, Suzuki, 2007) on timbre perception via a systematic control of other performance parameters. This study has not set out to directly examine touch types, but instead has focused on whether or not listeners could detect the expressive intention behinds these touch types. In other words, this perceptual experiment is not interested in the recognition of action **types** (percussive or non-percussive), but rather the recognition of expressive **intentions** that are both metaphorical (e.g. bright, dark) and physical (e.g. relaxed, tense). This study has demonstrated that pianists were very capable of expressing such abstract intentions in the performance sessions. Participants in the listening session also indicated their agreement and consistency in mapping the timbre perception onto various dimensions such as: relaxation/tension, physical impressions of texture, shape, and visual or affective imaginations like bright/dark colour. Examining timbre perception in an actual musical performance context gives greater opportunity for the investigation of cross-modal associations with musical sounds.

Unlike the systematic control of performance parameters in the studies listed above, this study has allowed the participants freedom in the use of musical attributes such as performance timing, dynamics, and articulation, acknowledging that these elements can influence musical perception. Also, in this study there is a reflection of holistic views of piano timbre by the pianists as demonstrated in the first interview study. The choice of performance tempo and dynamics enables freedom of musical interpretation for performers in a natural performance context. When instructed with particular timbral intention, the personalised choice of dynamics and tempo by the

three pianists is a good example of how audible changes in performance parameters is an effective tool in the personalised sound palate for different pianists.

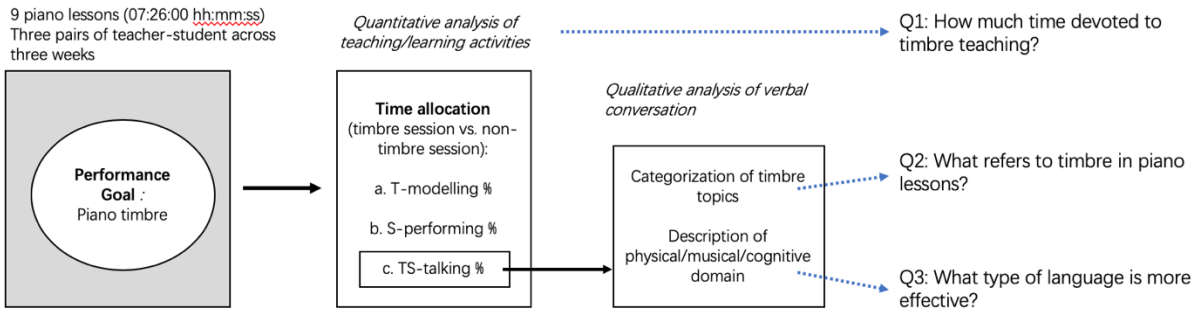
This study also extends and develops the notion of musical communication beyond the traditional scope of emotional communication. Previous literature has clearly indicated that timbral nuances in a musical performance are usually studied in relation to music-related emotions. For example, the employment of various timbres in performance as an effective tool for the expression of distinct emotions (Traube's study on guitar timbre); it is also an outcome of perceived emotions induced by music (Holme's study on guitar timbre). These studies place emotional communication at the centre of music performance, and timbral nuances in a secondary place in the creation of emotional communication. However, my study has demonstrated that sound can be the goal of music communication, and may be associated with sensory feelings, interoceptive sensations, mental images, and emotions. When the sound becomes the goal, the variations of timing and dynamics, as well as the visual presentation of the performance (gestures, movements), become the outcome of the ultimate goal.

Future research may be able to use point-light displays to replace bodily movement in the videos, to avoid the influence of familiarity of performers, or the influence of facial expressions. This method could also help to create congruent or incongruent stimuli, by synchronising the movement features of one stimuli with the performance data of another stimuli in terms of onset/offset time, duration, dynamics, and pedalling. Various methods of stimuli generation and study design have been fully explained in the study of Vuoskoski, Thompson, Clarke, and Spence (2014). For example, a new artificial video can be generated via synchronising movement features in a 'tense' performance with the sound signal of a 'relaxed' performance, examining the extent to which visual information influences or modifies listeners' judgements.

Chapter 9: Teaching Observation Study Results and Discussion [6]

9.1 Background

A three-week teaching observation study was conducted to better understand the process, approaches, and teacher-student behaviours related to the teaching and learning of piano timbre. This chapter will present pre-questionnaire data which investigated general views on the teaching and learning of piano timbre of participants, but the main focus of data analysis concerns the video-footage of nine piano lessons, which examines overall time allocation of timbre targets, topics of timbre targets, teacher-student behaviours, and domains of verbal descriptors of timbre. The time allocation of timbre targets (section 9.3 & 9.5) helps to give an overall picture of time spent on timbre targets in observed piano lessons and indicates differences between the three pairs of teachers and students. The aim of the sections regarding types of timbre targets (section 9.4) and domains of verbal descriptors (section 9.6) were to understand what timbre refers to in piano lessons and the relevant verbal strategies. The role of dialogic teaching strategy and non-verbal behaviours in facilitating the communication process are investigated in section 9.7 and 9.8. The logical relationship between research design and the research questions is explained in Figure 9.1 below.



[6] Some materials of this chapter and chapter 5 were submitted as a manuscript for the Frontiers in Psychology, co-authoring with Prof. Renee Timmers.

Figure 9.1: The design of the teaching observation study and its correspondence to research methods and questions employed in the study.

9.2 Pre-Questionnaire Results

All teachers responded with 'yes' in answer to the question: 'Is it possible to teach timbral nuances?' and all students answered 'yes' when asked: 'Can you change piano timbre successfully in your performance?' They also gave the highest rating in answer to the question: 'How important is timbre teaching/learning in a piano lesson?'

Regarding the question of time allocation to either the beginning, middle, or final stage of learning/teaching a new musical piece, the two teachers differed from the students. Teachers dedicated relatively more time to timbre (who chose 'a lot') than students (who chose 'a little' or 'moderate') at both beginning and middle stage, but they both thought the amount of time devoted to timbre was 'most of the time' at the final stage of teaching/learning a new musical piece. This reflects the difference in the views of teachers and students in terms of time allocation, which is verified in the quantitative data in the present study.

The last question in the questionnaire was open in design, to ask their opinions of influential factors related to the teaching and learning of piano timbre. In the responses of the two teachers and three students, the importance of 'touch angle and direction' was mentioned four times (T1, T2, S2, S3), followed by 'hand movement & body gesture/posture' (T2, S3), and 'student's understanding' (S2, T1). The factors mentioned only once included 'metaphorical description' (S1), 'musical structure' (S1), 'touch weight' (T2), 'teacher's instruction' (T1), and 'emotion of the music' (S3).

The results of the pre-questionnaire, therefore suggest the importance attributed to the teaching and learning of timbre in piano lessons in the opinions of both teachers and students. The following section will quantify how much time was actually devoted to timbre-related events and non-timbre related events in piano lessons.

9.3 Time Allocation

The percentage of time spent on teaching/learning timbre in a piano lesson is calculated by dividing the time allocated to considering timbre by the duration of the entire piano lesson. The duration of each lesson ranged from 37 to 57 minutes (Mean = 49'36'', SD = 7'53''). The amount of time spent on the teaching and learning of timbre also varied across groups and weeks. Table 9.1 displays the length of piano lessons and timbre events, as well as the number of timbre events. The details of time allocation and teaching/learning events for each group will be further explained in Section 9.4. Table 9.2 shows information relating to participants, materials, and bar numbers when working on timbre targets in three pairs of teachers and students. The average percentage of time focused on timbre in the nine piano lessons was around 32.95%, and was 30.32%, 41.86%, and 27.99% in Pair A, Pair B, and Pair C respectively.

Table 9.1: The duration and number of events spent on teaching/learning timbre in a piano lesson across three weeks in three groups.

	Week 1			**Week 2**			**Week 3**		
	Lesson length	Timbre length	Event number	Lesson length	Timbre length	Event number	Lesson length	Timbre length	Event number
Pair A	46'40''	*18'19'*	**12**	37'15''	*9'38''*	**11**	42'35''	*10'39''*	**9**
Pair B	55'50''	*20'58''*	**9**	55'40''	*22'00''*	**10**	41'30''	*20'08''*	**7**
Pair C	58'44''	*6'16''*	**4**	57'30''	*20'44''*	**8**	50'40''	*22'13''*	**6**

There was no remarkable difference in the amount of time spent on timbre in any one piano lesson of the three pairs, apart from the first week of Pair C in which a lower percentage was observed and related to a lower proficiency level. In the first week, Pair C spent more time on other performance targets such as correcting musical notation, rhythm, tempo, given that the view of the teach was that: 'the student's proficiency is not up to the required level' (T2).This result indicated that the teaching of timbre will be negatively affected by performance fluency and accuracy, and the student's ability to play the music accurately.

Table 9.2: The participant's information and the selected pieces in three groups.

Teacher-student Pair	information	Performed piece	Timbre information (Bar numbers by weeks)	
Pair A	Teacher T1 (Female); Student S1 (Master's student, female);	*The seasons,* composed by Tchaikovsky, 1876	*Week 1*	*<May> bar 3, 4, 7-8, 9, 10-11, 14-15, 35-38, 54; <June> bar 3*
			Week 2	*<May> bar 13; <June> bar 2, 4-5, 36-39, 50-51, 99; <Oct> bar 1, 7;*
			Week 3	*<Oct> bar 22, 32-33; <Nov> Bar 1, 17, 29, 48, 82*
Pair B	Teacher T2 (Male); Student S2 (undergraduate year 4, female);	*Malaguena* composed by Ernesto Lecuona, 1933	*Week 1*	*Bar 1-5, 28-42, 42, 43-55, 55-56,58-60, 61, 65, 69, 105-110, 125-132*
			Week 2	*Bar 1-9, 16-17, 35, 57, 58-60, 70, 71, 103*
			Week 3	*Bar 1, 21-27, 26, 58-60, 65, 69, 114*
Pair C	Teacher T2 (Male); student S3 (Undergraduate year 1, male);	*Small Preludes and Fughettas* (pieces 1, 5, 8) composed by J.S. Bach.	*Week 1*	*No. 8: bar 1-4; 9-10; No. 1: bar 1-4*
			Week 2	*No. 5: bar 1; No. 1: bar 1-10; whole piece;*
			Week 3	*No. 8: 1-6; 7-8; 17-18; No. 1: whole piece (right hand);*

9.4 Types of Timbre Targets

After familiarization with the whole data set, I tried to summarise the information of each video excerpt with a label (e.g. 'think timbre as a man's voice'; 'timbre and hand coordination'; 'timbre of the last note'; 'horn-like timbre' etc.). Through comparing and categorizing of the labels, two types of timbre goals stand out from the whole data set (77 timbre-related events), namely Metaphorical Timbre (30) and Ideal Timbre (23). The rest of the timbre-related events only occupied a small portion of the data, so they were removed from the analysis.

Metaphorical Timbre. This timbre goal was named by the teachers as vivid visual/aural images, such as a male/female voice and shimmering river (Pair A), Brazilian dancing and a bell-like sound (Pair B), and Lute timbre on a piano (Pair C). These metaphors were found to be used coherently by the teachers over three weeks, and work as an impressive sign in the verbal communication process (Examples: see Table 9.3-9.5). Interestingly, there are several types of adjective descriptors commonly used by all three pairs of teachers and students, for instance, bright, dark, rich, heavy, open etc. These results are also in accordance with previous verbalization studies on timbre (Bellemare & Traube, 2005). In addition, Metaphorical Timbre is seen as closely related to emotional expression, for example, T1 explained a relationship between affections of struggling, doubting, and needing, and the imitation of a male/female voice on the piano; T2 associated the metaphor of Brazilian dancing with emotions of free, open, and enthusiastic.

Ideal Timbre. This type is closely associated with an aesthetic dimension in the evaluation of tone quality, where teachers often use language referring to: 'goodness/badness', 'appropriateness', 'beauty', and 'satisfaction'. This is consistent with previous explanations of a quality dimension of piano timbre, for instance, a perceptual assessment of sounds regardless of other musical attributes (Marozeau, 2004), and a subjective reaction and unified experience of piano tones (Ortmann, 1938). It is noteworthy that two teachers often used the expression 'THE sound' or 'THIS sound' to refer to Ideal Timbre. The teachers, therefore, have clear criteria of 'what is good

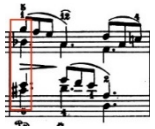
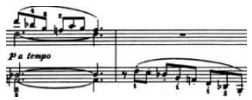
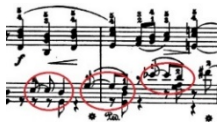
or bad' and 'what is right or wrong' and encourage the student to follow these values. With the teacher's appraisal and feedback, the students learnt to avoid making wrong/bad/undesired timbres by using particular playing techniques.

The following sections will present a detailed explanation of the teaching and learning of Metaphorical Timbre and Ideal Timbre in each of the three groups. Musical examples and relevant quotations related to each topic are included in the relevant tables.

9.4.1 Pair A.

In general, this pair worked on the musical piece in a progressive manner: they selected four short pieces from the complete set of the seasons and worked on at least two pieces in each lesson. Table 9.3 below shows a summary of each timbre event of Pair A over the three weeks. This pair worked on the type of Metaphorical Timbre that includes a fuller timbre, horn-like timbre, and timbre of a shimmering river etc. The teacher also explained the compositional background of the horn-like timbre in <June> (bar 36-39), that the composer wanted to imitate the scene of boat trackers' work using the rhythmic pattern and accents. In addition to the use of metaphorical language, this type of timbre target was closely linked with concrete descriptors of physical aspects (e.g. utilisation of body, force, touch) or with the aid of emotional expression descriptors (see quotations inserted in Table 9.2 below: <June>bar 36-39; <Oct> bar 22). The other type of timbre target related to an Ideal Timbre in a certain context, in which the teacher usually evaluated the timbre as 'good' or 'bad', 'right' or 'wrong', and 'proper' or 'desired'. The communication of this topic usually referred to a right type of touch, for instance, the use of a flat finger and gentle touch to get a proper sound at a soft beginning of a phrase of <Oct> bar 1 while using sensitive, rapid, and non-percussive touch to play the quick and intensive semiquaver notes in the example of <Nov> bar 48.

Table 9.3: Examples of timbre events in Pair A (translation by myself, *italicized text* and marked areas in the score indicate the features of represented type).

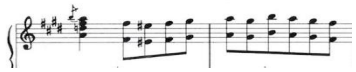
Weeks	Types of timbre targets	Bar Information	Examples (scores & quotations)
week 1	Metaphorical Timbre (emotions)	<May> Bar 3; <May> Bar 4; <May> Bar 9;	 'The sound –isn't it too *cracked*; Let me hear the *density* of the sound--have *tension* inside, with an expression that is *painful and struggling*' <May> Bar 3 (first chord)
	Metaphorical Timbre (imageries)	<May>Bar 10-11	 'These two phrases are a conversation between the *princess and the earl*; These two have different timbres--you should express clearly'
	Metaphorical Timbre (adjective descriptors)	<May>Bar 35-38; <June>Bar 3	'The timbre should be *brighter;* don't use straight arms-open, open'; 'Every note should be played *fuller*-the sound is *going down*, don't beat'
Week 2	Metaphorical Timbre (imageries)	<May>Bar 13 <June>bar 50-51	'You can interpret as *men's voice*. Not only crescendo, but much *thicker*' 'Sound of *shimmering river*'
	Metaphorical timbre (imageries)	<June>Bar 36-39	 *'Horn-like'* timbre 'Use the arm's energy; do the action of falling-lifting, falling-lifting. Don't beat at the second note'
	Ideal Timbre	<Oct>bar 1; <Oct> bar 7	'Use your finger pad, softly touch the key—to get a *proper* sound' 'Don't have *THIS* sound in this context'

Week 3	Metaphorical Timbre (adjective descriptors)	<Oct>bar 22; <Nov>bar 17	'Isn't the timbre too *bright*? [It] should be very depressing, squeezing in your heart.' 'Play with crescendo. It's the development part-the timbre is much *more open*.'
	Ideal Timbre	<Nov>Bar 29; <Nov>bar 48;	'Use *non-percussive touch.* Keep fingers close to the key and make rapid force, so as to get the *desired* timbre.' (bar 48)  'Using your fingertips--very sensitive touch—a focused force on a very tiny point…The *quality* of that tone is *very high, very good.'*

9.4.2 Pair B.

This pair worked on timbre in a repetitive but dynamic manner: they focused on the same piece of music but the details of teaching and learning of timbre varies in each week: for instance, they worked on the beginning phrase (bar 1-9) over the three weeks, but dealing with different timbre targets in each lesson (left hand in week 1, right hand in week 2, and Scherzo character in week 3). The details of the timbre events of Pair B are summarised below (Table 9.4). In addressing the type of Metaphorical Timbre, the student in this pair learnt how to work on a full timbre, darker timbre, elastic timbre, or bell-like timbre. Quotes are shown in the table to explain what the teacher referred to. Apart from this, this teacher and student usually worked on Ideal Timbre, in which situation the teacher (T2) frequently referred to the expression of 'THE sound'. The type of Ideal Timbre in this pair was associated with technical difficulty of the music—rapid octaves (see No.2 score), which were practised in the first two weeks in successive bars of the music. This technical aspect of timbre production took a longer time (7 minutes) to work on in the first week; the performance improved in the second week (shorter time), and the problem was resolved in the third week (no time slots).

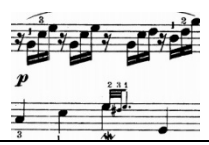
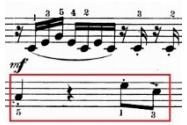
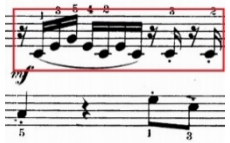
Table 9.4: Examples of the timbre events in Pair B.

Weeks	Types of timbre targets	Bar information	Examples of scores, quotations
Week 1	Metaphorical Timbre	Bar 58-60 (adjective descriptors) Bar 42; (emotions) Bar43-55 (adjective descriptors)	'The *richness* of the sound is missing. It's not only related to musical dynamics. See, one is flat finger, the other one is curved finger'. 'You can absolutely make the sound more *contrastive and exaggerated*' 'Don't use the wrist, otherwise the played sound is too *heavy*.'
	Ideal Timbre	Bar 43-55, 105-110, 125-132	 Work on the technical difficulties of rapid octaves to get the RIGHT sound.
Week 2	Ideal Timbre	Bar 1-9; Bar 16-17;	'Don't play heavily; use instant energy, like grasping, to get *THE sound*' '*THE sound* should be like this; don't be jerky '
	Metaphorical Timbre	Bar 35; (imageries) Bar 57; (adjective descriptors) Bar 58-60; (adjective descriptors)	'Don't throw the 'bomb'; it should be like the *sound of a bell* from a distance' 'This tone should be very *bright*--instantly come out' 'This tone is not full enough'
Week 3	Metaphorical Timbre	Bar 1; (emotions) Bar 114 (adjective descriptors)	'You are lack of the Scherzo character in the timbre; a sort of quick and elastic thing in the sound' 'Why you failed to make a *darker* sound? You should try to slowly stroke the key'
	Ideal Timbre	Bar 26 (left hand),	'That's right. *THE sound* comes out!'
	Metaphorical Timbre	Bar 58-60 (imageries)	'the timbre of this series of note, is quite the [description of] *Brazilian people*….[that describes] the way they dance'

9.4.3 Pair C.

This pair worked on three pieces chosen from J. S. Bach's *little Preludes and Fugues* but working on different pieces in each week. Table 9.5 below summarises the learning and teaching events of Pair C related to timbre, including specific examples from the sheet music and direct quotes. One key feature of this pair was that the teacher sometimes seemed to work on the timbre of the entire piece. This might have been because the selected pieces are short in length, or because the repetition of rhythmic and melodic patterns that make the teacher want to vary the interpretation. Meanwhile, the teacher tended to emphasize the use of the right playing techniques and touch to get a 'better' sound for that piece. For example, the regulation of energy (initiated from the body) and the strength/firmness of the finger are frequently mentioned in their conversations. Additionally, the Metaphorical Timbre of 'lute timbre on the piano' was an important task in this group although the teaching/learning activities varied in each week: conversation in week 1 mentioned the use of staccato performance in the left hand and the compositional background of the piece (which was composed specifically for lute); in week 2 and 3, the learning was extended with explanations of specific techniques and types of touch, and the teacher drew a parallel between guitar playing and piano playing, suggesting that the imitation of the guitar sound on the piano is based on the imitation of similar playing techniques and similar sonic effects (quotes are given in Table 9.4).

Table 9.5: Examples of the timbre events in Pair C.

Weeks	Types of timbre targets	Bar information	Examples of scores, quotations
Week 1	Ideal Timbres	<No. 8>Bar 1-8	 'The touch in two hands are different-the call is at the bottom while the response is at the top—it's two different sounds'
	Ideal Timbre	<No. 8>Bar 9-10	'soft is soft, not weak. Why is your timbre so weak?'
	Metaphorical Timbre *(lute timbre on the piano)*	<No. 1> whole piece (left hand)	 'It is like *the sound of a lute*; it is also composed to imitate the lute, so the left hand must be *staccato*.'
Week 2	Ideal Timbre	<No.5> whole piece <No.1> whole piece	'you always play without support; *your hands are loose*, so you cannot get a ringing sound in your playing' 'In your entire performance this time, can you feel that the energy is from *the back* not from *the finger solely*?-It's two different types of sounds'
	Metaphorical Timbre *(lute timbre on the piano)*	<No.1> whole piece (right hand)	 'Your hands are so loose. Actions of strike and release must be very rapid.'
Week 3	Ideal Timbre	<No.5> whole piece	'Different playing techniques will bring different sounds; *the beauty* represented by different sounds would be different. Harmony, dynamics etc. are just one aspect of that' 'When there is little change in the dynamics, try to change the touch'
	Metaphorical Timbre	<No. 1>whole piece	'The sound of the string instrument-after the vibration of the string-is not dead and stiff; instead it is lasting. If you want to imitate the sound, try the plucking techniques of playing the guitar on the piano'

9.5 Teacher-Student Behaviours in Timbre Session and Non-timbre Session

Three types of teacher-student interaction behaviours (T-performing, S-performing, and TS-talking) were observed in this study, in terms of the time allocation of each type of behaviour. Comparisons were conducted between timbre sessions and non-timbre sessions, to feature the differences between the teaching and learning of timbre targets and of other performance targets. In Figure 9.2, the left panel provides a summary of the teaching and learning in timbre events, while the right panel provides a summary of the remainder of the time that was not spent on timbre. The bars represent different weeks, while colours display the percentage of each type of TS behaviour in a lesson

Over weeks. Taking a look at the timbre sessions in the three groups, one of the common features is that the percentage of TS-talking gradually increases over the three weeks in all three pairs. This might be partly be due to the design of observation schedule: that of progressively working on timbre over the weeks and applying dialogue teaching in the third week. The amount of TS-talking increased in timbre sessions while less T-performing happened over weeks in two of three pairs.

Timbre and non-timbre sessions. Teachers and students in this study mainly worked on emotional targets, understanding musical characters, analysing the score, and correcting mistakes, in the non-timbre sessions. When comparing all timbre sessions with non-timbre sessions, it is clear that talking was adopted more in timbre sessions while S-playing took large proportion in non-timbre sessions. It indicates that language plays a more important role in communicating timbre targets; while student-practice seems to work more effectively when working on other performance goals. In non-timbre session, perhaps the students were capable of correcting mistakes and accomplishing these non-timbre goals by actively playing and practising in the lesson; while timbre goals need the cooperation of both the teacher and the student and more exchanges of behaviours of TS-talking, teacher's playing, and student's playing.

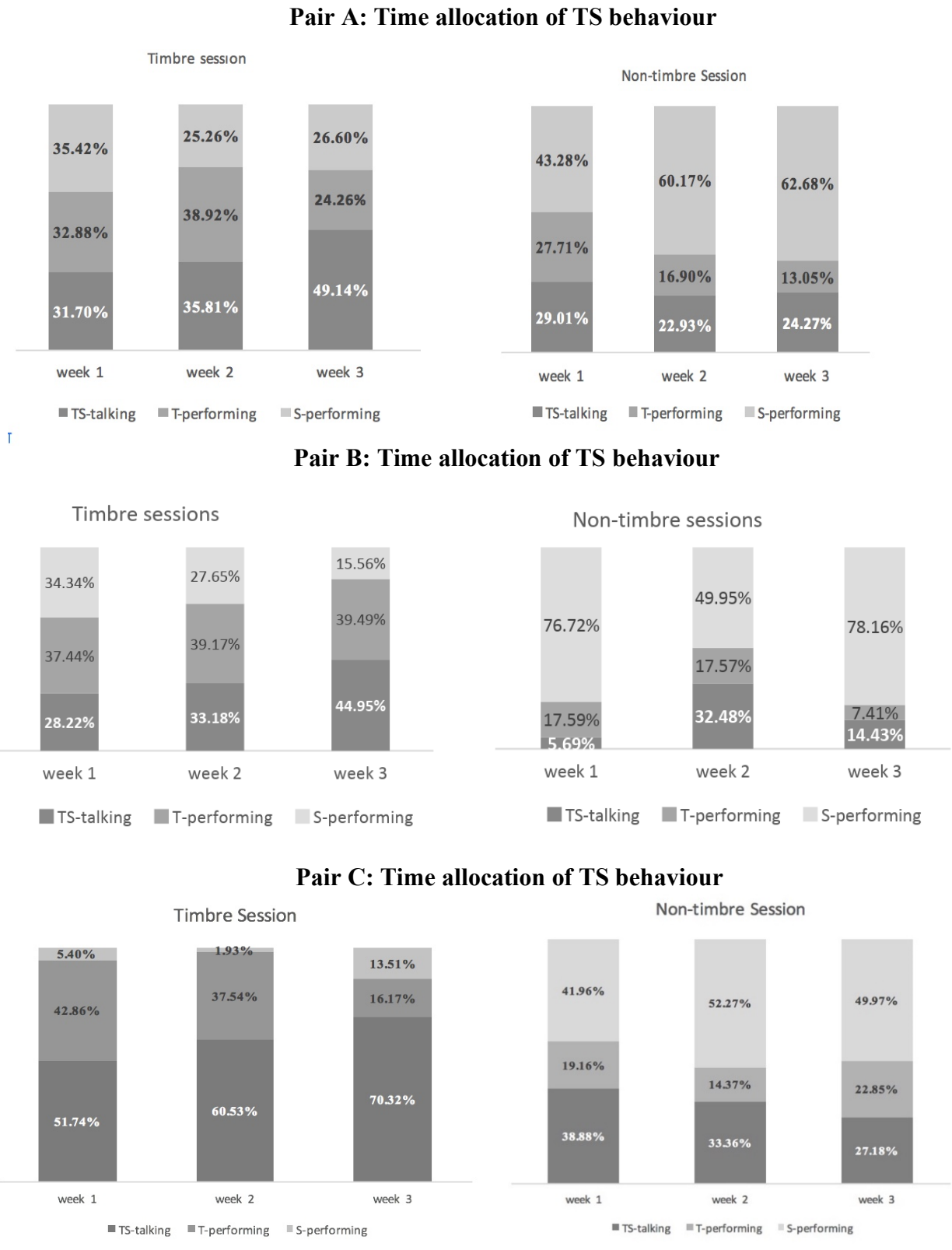


Figure 9.2. Time allocation of TS (teacher-student) behaviour in Pair A (top), Pair B (middle), and Pair C (Bottom), with a comparison between timbre sessions (left) and non-timbre sessions (right). Bars=weeks, colours=types of TS behaviour.

The observation of teacher-student interaction behaviours is a good indicator of the effectiveness of piano lessons. Both Pair A and Pair B had a good balance between each type of TS behaviour, therefore I would suggest that both were more effective than Pair C when working on timbre targets. This assumption could be verified by conducting a follow-up evaluation study that asks expert judges to rate the effectiveness of various video fragments, and the results being concerned with its correlation with the numbers and durations of TS-behaviour exchanges. As suggested by Küpers, Dijk, and Geert (2014), a frequent exchange of behaviours between the teacher and the student, as well as overlaps of TS behaviours, are good indicators of active participation from both. In addition to the extent of participation, Siebenaler (1997) stressed the importance of teacher interruption in the student's performance: 'a large percentage of uninterrupted performance time often indicated a struggling student without appropriate teacher intervention.' (p. 17). This study found a similar statement from S2 (Pair B) in the post-interview: 'When I finished a rehearsal trail, my teacher started with long, but general and off-task talking rather than correcting my performance, I knew I was not doing well, but he didn't even want to comment on my performance.' The following sections will explain, when the teacher and student communicates, the extent to which the use of vocabulary and dialogue facilitate the communication process.

9.6 Vocabulary: Three Domains of Verbal Descriptors

The coding of musical/physical/cognitive-domain descriptors was conducted using NVivo. This software can also generate frequency of appearance. These are shown in Figure 9.3 below, together with corresponding subcategories. The physical-domain descriptors (151) occurred with a high frequency in the verbal communication of timbre, followed by the musical-domain descriptors (82) and cognitive-domain descriptors (67). The coding schema has been explained in Section 6.4.5.

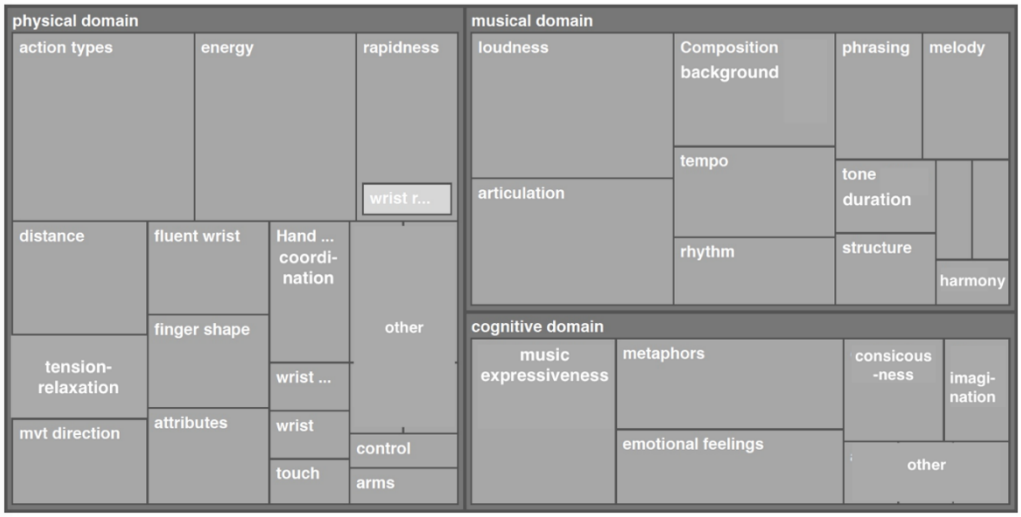


Figure 9.3. Chart of linguistic descriptors from physical/musical/cognitive domain, in which the size represents the hierarchy of frequency of the items.

9.6.1 Physical domain. (codes number: 151)

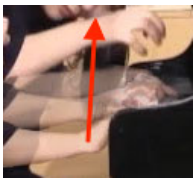
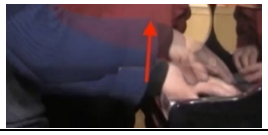
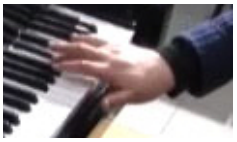
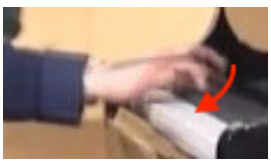
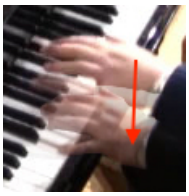
Physical-domain descriptors were the most frequently mentioned domain in the verbal communication of timbre. The most highly occurring subcategories were energy, actions, and speed.

Energy (44). The discussion of physical energy or force related to several aspects: (1) where the energy was originating, i.e. from the arms or fingers, or from the back; (2) the amount of weight (more or less, heavy or light); (3) the change in use of energy (decrease/increase the energy in a certain time phase); (4) the continuity and stability of the energy.

Action (41). The teaching and learning of various types of action was also an important category within the physical-domain descriptor. Different types of touch on the piano keyboard were covered, and the verbal instruction referred to the extent to which the student used their body (e.g. finger, wrist, and arm) but also other specific attributes of the touch such as speed, weight, direction, and duration. The teaching process relied heavily on the teacher's demonstration of both the 'right' and 'wrong' types of physical action. Together with an aural example, this gave the student a continuous and contrastive experience of touch and its impact on timbre. Table 9.6 below

illustrates several examples of action-type descriptors accompanied by either superimposed images or arrows showing the trajectory of movement(s).

Table 9.6. Examples of physical actions and the corresponding explanation in words and movement.

Physical actions	Verbal explanation	Images
挑tiao	Using one finger to touch the key in readiness, like 'pulling a string with nails' together with a rising hand. (T1)	
提ti	Similar to *tiao*, but with an emphasis on lifting the wrist. (T1)	
勾gou	The end of the finger is acting like a hook with an upward movement. The touch is very short and crisp but elastic, where the wrist keeps almost still. (T2)	
	Wrong action demonstration by the teacher: In the playing of a quick passage of octave chords, it is wrong to use too much wrist moving up and down, which caused 'heavy' and 'dead' timbre. *	
拂fu	To brush. Use of very flat finger rather than curved finger to gently touch the key. This is used in the playing of darker timbre. (T2)	
	In opposite with the preceding item 'fu', the use of a very curved but not angular finger helps to make a brighter timbre.	
抓zhua	A rapid sliding motion on the keyboard, like 'grasping movement', using a quick and short touch inwards. This is used to produce an elastic timbre. (T2)	
推tui	Use of a lower wrist to push the weight into the keyboard. (T2)	

*拍pai**	Use of very quick and jerky movement. Striking the piano, like 'beating', up and down to the piano. * (T1)	
*抽chou**	This is similar to *Pai,* but with a jerky movement inwards. * (T1)	

*Note: actions marked with * were less preferred by the teachers who recommended to avoid using these actions in piano playing.*

Speed (19). The readiness and speed of finger movement is a key feature in the production of timbre. As T1 explained to her student, S1, striking the key promptly helped to make a 'ringing' and 'crystal' sound, and like 'being stung by a bee'. In addition, T2 claimed that the 'leaving' speed of the touch determines the produced sound quality, rather the 'striking' speed. According to Kochevitsky (1967), the practice of finger rapidity and readiness is one of key skills in the development of a virtuoso pianist.

9.6.2 Musical domain. (codes number: 82)

The most frequently occurring descriptor from the musical domain was that of volume (34), which was considerably higher than articulation (12), tempo (8), tone duration (4), and phrasing (4). This is consistent with pre-existing definitions of piano timbre that have referred to musical dynamics; for instance the notion of 'the illusion of hues by dynamic contrasts' raised by Hamilton (2012).

The quotes from the conversation between teachers and students are shown below. Both cases imply that teachers conceptualise timbre as distinct from dynamics. Case 1 suggests the extent to which teachers associated timbre with the concept of beauty and other musical parameters like dynamics/harmony are only part of it; Case 2 indicates the influence on touch types makes timbre distinct from dynamical change.

Case 1 (Pair C)	T: The homework I gave you last week, is to think how to improve the sound. S: Yes, I wanted to make a crescendo from here. T: How about the touch (to change the timbre)? Don't just think of making contrasting dynamics, that's just one aspect. Different techniques will bring different timbres, different timbres represent beauty in various ways. How do you make a more beautiful sound? *Harmony, dynamics, are just part of it*.

Case 2 (Pair B)	T: You lack variation here. You only made changes to the volume, louder or softer, but little is done on timbre. That is to say, one (part) uses flat finger, one (part) uses curved finger.

9.6.3 Cognitive domain. (codes number: 67)

References to a metaphorical idea (23), an emotional feeling (19), and expressiveness (15) were the three most common approaches in the cognitive-domain descriptors. Using a metaphorical approach, the physical aspect of timbre production was taught by drawing parallels with everyday movements. 'Playing is like walking.' was a frequently occurring comparison among the three groups, where the parallel was made between finger movement and leg movement to metaphorically explain the influence of speed, continuity, weight and height on timbre. Vocabularies relating to emotions and feelings were used frequently by the two teachers, such as pleasant, awe, desire, mysterious, sad, calm, depressing etc. The vocabularies used to describe musical expressiveness include contrasting, exaggerating, non-expressive, plain, deadpan, straightforward etc. The teachers in this study used these words to instruct their students to vary the degree of expression.

9.6.4 Types of timbre targets and Verbal descriptors

NVivo can help to count the number of nodes, but also the number of nodes in different cases. Therefore, it was used to calculate the frequency of occurrence of three domains of verbal descriptors (i.e. nodes) when referring to different types of timbre targets (i.e. cases). This approach helps to examine the sub-research question of: whether timbre targets are understood via concrete musical results, physical means, or emotion/metaphor-oriented instructions. A summary of the first three most frequent types of timbre targets is shown below. Table 9.7 indicates the relative percentage of physical, musical, and cognitive-domain descriptors occurring in each type of timbre targets:

Metaphorical Timbre. The linguistic descriptions used in this category are more likely to be associated with the cognitive-domain (32), such as the use of metaphors, expression, or emotions. The descriptors from the physical domain (28) and musical domain (20) were also very high in frequency, indicating that the abstract and expressive ideas of timbral intentions were made concrete and precise in certain musical contexts via specific physical means.

Ideal Timbre. The language used to explain this category of timbre is mainly associated with physical-domain descriptors (70), considerably higher than the appearance of musical-domain descriptors (17) and cognitive-domain descriptors (16). This indicates that this type of timbre target is more relevant to the preparation of bodily movements and performance techniques to achieve a timbre target, especially via the use of action-type words (Section 9.6.1).

Table 9.7. Frequency of occurrence and relative percentage (in brackets) of the timbre descriptors in the three domains for each type of timbre targets.

Types of timbre targets	Examples	Physical domain	Cognitive domain	Musical domain
Metaphorical Timbre	Abstract adjectives (fuller) Vivid visual-aural image (bell sound) Emotional expression (painful)	28 (35%)	32 (40%)*	20 (*25%*)
Ideal timbre	Evaluation of performed sounds	70 (*68%*)*	16 (*15.5%*)	17 (*16.5%*)

*Note: the asterisks * indicate the highest relative percentage for each type of timbre target*.

9.7 Dialogic Teaching

As part of the exploration of interaction patterns between the teacher and student, the two teachers in this study were instructed and encouraged to use dialogic teaching during the final week's teaching observation session. Even though they made clear that they were already familiar with

this approach and use it in their teaching routines, an interference effect was still found in the teaching and learning of piano timbre specifically: the amount of TS-talking increased to the greatest amount in the final lesson for all three pairs of teachers and students. The open-question samples (see Appendix 11) that were given to the teacher in the final lesson to facilitate the dialogic teaching, did influence their verbal instruction. They adopted more open questions and gave more space for students to respond in these sessions, instead of asking forced questions. Analysis will take into consideration all fragments over three weeks that involved dialogic teaching.

This study found a difference between the female teacher and the male teacher in terms of the preference for using dialogue, and the type of dialogic teaching. The male teacher preferred to use dialogue (N = 20) more than the female teacher (N = 5) in the communication of timbre targets. The female teacher raised several questions but the student was too nervous to answer and just responded with head nodding and smiles. This might also have been because using dialogue was in conflict with their ordinary routine of working on timbre, so the student felt uncomfortable in answering in front of the camera.

The dialogue used in the male teacher's groups contain both teacher-initiated dialogue and student-initiated dialogue. *The teacher-initiated dialogue* happened intuitively after the student's playing as part of giving appraisal, clarifying mistakes, or giving further instructions; for instance: 'You lack timbral change here', or 'It should be very light – don't play heavily.' (T2); in addition to giving explanations/instructions, there was also a use of short and close ended questions to ask the student's intention and check their understandings, for instance 'Isn't it too bright?' (T1), 'What instrument do you think is it [the timbre] imitating?' *Student-initiated dialogue* was used to actively share their opinions, knowledge, and thoughts, and even confusion, for instance: 'I don't know to how to vary the sound.' (S2), 'Is it [timbre change] about the contact size of the fingertips?' (S3); the teacher facilitated the communication process by actively listening, and scaffolded the student's learning by explaining, demonstrating, and clarifying.

Quotes from Pair C were selected below (interpretation from my perspective has been inserted in square brackets and underlined). The teacher's questioning has a positive influence on student's independent thinking -- the student learnt to discriminate differences in piano timbre and use particular metaphorical descriptors to express their feeling, including those of 'deeper', 'solid', and 'heavier'. The teacher further complemented with a statement of prospective feeling, to let the student feel differences in timbre by distinguishing 'where the energy comes from'.

Example 1:

T2: ...Have a listen this time, what do think is different compared to last time' [T starts with an open question].

S3: It's deeper…[S's response]

T2: [Hmm…] Did it change? What do you think changed? [T rephrases the question and wants more explanation from the student].

S3: Well, this time I felt the sound was more 'solid'- compared with the last performance – which was 'crisp' – this one was more 'solid, and 'heavier'. [S explains the difference in more detail].

T2: The reason for the so-called heavier sound was because you played heavily. [T explains the technical reason for what caused a 'heavier' sound]. *But you should – and maybe you're not – feel the energy flowing from the back of the hand and going through the fingers.* [T tries to guide S to think of the use of energy].

S3: Yes, I felt that.

Another example was selected from the Pair B, in which dialogic teaching helped to diagnose the student's needs and frame their learning tasks (Alexander, 2010). The following excerpt reflects how a conversation on timbre switched to an analysis of musical structure when the student failed to understand the teaching's meaning:

Example 2:

T2: You lacked a change here. It was just a change in ***dynamics*** *– the* ***timbral*** *change is too limited. That is to say, one is to do with using a curved finger, while the other is to do with a flat finger. The key difference in timbre is here. [T started to demonstrate]*

S2: So I need to be slower here? [The student hasn't understood the idea of timbral change]

T2: No. [T's response to the student] *How many sections in this phrase?* [The teaching content has changed]

S2: Three. [Following the teacher's second demonstration] …Oh I know – the slowest part is at the end.

T2: Yes, from here [beginning] to here [end] is an entire phrase. However, in terms of the touch, what can we do with the timbre? Although it is all indicated with accent markings, it should have a change of musical expression and intention. One type of touch does not communicate enough expression. [The topic back to timbre again].

The above statements and examples demonstrate the benefits of using dialogic teaching to facilitate the teaching and learning of timbre targets. A shared conception of timbre was co-created by active contributions from the teacher and the student (Alexander, 2000), followed by a pattern of, either teacher-initiated dialogue (i.e. teacher diagnoses mistake then student comments their understanding), or student-initiated dialogue (i.e. student seeks for help then teacher clarifies and expands the answer). During this process, the knowledge in terms of the utilisation of bodily movements and the relevance to other performance cues and musical structure was exchanged actively between the teacher and the student. However, this study acknowledges the difficulty of employing a dialogic approach for less experienced teachers and students. The questions used by the teacher sometimes ended up being closed rather than open ended; or in some other cases, the conversation continued while the teacher tried to put their point across and gave less space/time to the student to respond. The sample questions were helpful to some extent, such as in opening the discussion, but the teacher and student sometimes need further training regarding how to facilitate the student's contribution and how the teacher can question the student more effectively. There are certainly some difficulties in this study such as: differing cultural backgrounds, personal differences, and shortness of time for observation.

9.8 Gesture and Physical Touch

It was interesting to note that in some circumstances, the teaching and learning of timbre targets was realised through neither words nor sounds, but through non-verbal behaviours such as direct or indirect physical touch and the teacher's mimicking gestures. This study did not systematically calculate the frequency and types of non-verbal behaviours as previous studies have (Simones et al., 2015; Zhukov, 2012). However, as an exploratory study with the focus on piano timbre, I have selected some interesting examples (Figure 9.4) to explain how non-verbal behaviours worked together with verbal behaviours:

Example 1:
Context: In the teaching of Metaphorical Timbre, T1 explained a painful and struggling feeling associated with the timbral effect.

Quotes:
T: 'more here…', 'The most…' **[with gesture]** '[Laughing]. Isn't this tone a bit harsh? It's cracking. You should have a bit control.' (*T-performing…*)

Gesture: T1 is pushing the student's body from her back forward.

Example 2:
Context: In the teaching of Ideal Timbre, T1 wanted the student to use a lifting wrist but with fingers close to the keyboard like wiping (not a struck touch)

Quotes:
T: "lift your hands, a little is enough" **[with gesture]**
(Following *T-performing…*)

Mimicking sound-producing gesture:

Figure 9.4: Non-verbal behaviours in the observation study.

The above two examples have identified a clear difference in the mimicking of sound-producing gestures between the two teachers – the female teacher directly touches her student to mimic the sound-producing action, while the male teacher mimics on his own hand. Additionally, the female teacher uses more direct touch (e.g. Examples 1 and 2) in the communication with the student; in Example 1, T2 did not give an explicit explanation of what refers to 'more', but she clarified her meaning through the direct touch by pushing the student from the back, which also changed the performance posture. It seems the expression of 'more' represents a mixture of more expressiveness, more energy, and more bodily movement.

9.9 General Discussion

9.9.1 Conceptualisation of piano timbre in piano lessons

This study has confirmed the assumption in Chapter 5, that the teaching and learning of timbre targets in the context of higher education has gone beyond technical skills, and is closely linked with aural, cognitive, and musicianship skills; as is reflected in the views of the teachers in the study. The communication of targets is inseparable from analysing the musical score/structure, balancing with other performance cues, understanding the compositional backgrounds, planning performance plans, and anticipating the sonic outcomes. The integration of mind and body becomes an important joint goal for both the teachers and students in this study, during which teachers gave feedback on a student's performance by bringing their bodily sensations into the thinking (e.g. 'too tense') while students learnt to produce better sounds by imitating the teacher's actions and adjusting motoric controls. In addition to the acquisition of technical skills (touch types, physical energy, finger dexterity, and readiness), the teachers also trained the student's intentionality in the planning and preparation of timbre targets (e.g. 'think before you play'), and improve their awareness on employing timbre (e.g. 'not only about dynamics'), and helps them to focus on preoperative feelings (e.g. 'feel where the energy comes from').

Finer motoric controls and skills relating to timbre production were gained by observing the teacher's modelling, the use of vivid metaphors and real-world analogies, and in-class practice. In this process, action-metaphors were demonstrated to be more effective than literal descriptions of physical energy, force, rapidness, and readiness. They encouraged the student to switch their attention from finger movement to a coordinated, balanced, overall bodily movement. For example, the actions of 'pushing', 'beating', 'holding', and 'pulling up' etc. which commonly exist in everyday human movements are useful tools for piano teachers to make analogies between these movements and piano technique, therefore enabling students to make more sense of the production of piano timbre. Aural sensitiveness was enhanced in the learning of piano timbre: for instance in the cases of Ideal Timbre, the pair of teacher and student constantly work on appropriate touch and movement type until it produced the tone quality required by the teacher.

The teachers' conceptions of piano is intended to strongly influence the students' perception. The desire of teachers is to sketch a multidimensional mental picture of the sound for their students by associating Metaphorical Timbre with aural-visual images and sensory experiences; to let the student be more aware of using timbre by clarifying the relationship and difference between timbre and other musical parameters; and to pass on their ideological and aesthetic understanding related to piano timbre to their students by relating piano timbre to the beauty and expression of music performance,

9.9.2 'In the same boat' – 'Student-centred' teaching and learning process

The teaching and learning of Metaphorical Timbre and Ideal Timbre seemingly fits several characteristics (e.g. student's imitation, teacher's authority) of a master-apprentice model that has been criticized by several scholars (Nielsen & Kvale, 1997; Jørgensen, 2000). For example, the teachers seem to hold the subjective criteria of what is 'right' and 'appropriate' in the production of Ideal Timbres and they employed verbal strategies (illustration of physical action types) and

non-verbal strategies (direct/indirect mimicking gestures) and wanted the student to imitate their sound-producing gestures and sounds. Additionally, the teachers took the authority to determine the proposition of metaphors and imageries in the teaching and learning of Metaphorical Timbres, and the students seemed to be required to 'accept' the indicated metaphors.

However, I would argue that the teaching process may nevertheless be 'student-centred' rather than 'teacher-centred' and that the teachers did stimulate the student's independent learning via verbal or non-verbal strategies, although further examination would be needed to confirm this. When the teachers gave personal criteria of what is the right or wrong timbre or touch, they are the masters who have expertise in the knowledge of tone production, and they wanted their student to 'copy' their gestures and sounds to acquire technical skills and to avoid possible injuries. However, the teachers had to actively listen to the student's performance, diagnose their troubles and needs, and guide their attention to experience visual, auditory, or kinaesthetic cues, which is an 'in-the-moment' and shared musical experience and there is a reciprocal interaction between the teacher and the student (Schiavio et al., 2020; De Jaegher & Di Paolo, 2007). The teachers also needed to understand the gestures and actions of the students, to experience the bodily sensations involved in the tone production process through the student's eyes. As Hyry-Beihammer (2010) argued, the teacher is 'in the same boat as the student' rather than taking a master's 'authoritative role' when we understand the master-apprentice model.

Furthermore, the metaphors and imageries that the teachers create are closely associated with the compositional background of musical pieces, which provides an opportunity for a shared focus on the musical work. The teachers ask their students to relate to the composer's intentions as far as can be inferred from the notation (e.g. Kivy, 1995) in their interpretation of musical works. More practically, they embodied the contextual knowledge in the teaching of performative actions, for example, the teacher used a 'fall-lift' hand action to imitate the 'yo-heave-ho' sound of a boatman when teaching Tchaikovsky's 'June'. Several metaphors and imageries were used

consistently by the teacher in the three weeks and there seemed to be a consensus between the teacher and the student since both did not need further re-explanations in using the same metaphor/imagery. In this sense, metaphors can be regarded as scaffolds that enlighten the student's utilization of performance gestures. Along with the teachers' repeated coaching and the student's continuous practising of the performative gestures, these linguistic scaffolds fade ('coaching-fading' mode, Byrne, 2005), together with a stronger feeling of autonomy in the student's learning process (Meissner & Timmers, 2020). Therefore, the meaning of an abstract metaphor or image such as 'lute-like' timbre and 'horn-like' timbre is *enacted* through an embodiment process (De Jaegher & Di Paolo, 2007), rather than existing as fixed, objective knowledge that transmits from the teacher to the student on the basis of a 'correspondence' schema.

9.9.3 Investigation of language use: Meaning construction of timbre targets

The investigation of the time allocation indicated that the communication of timbre targets needed more contribution of language than non-timbre targets. The proportion of talking increased over three weeks in the teaching and learning of timbre targets. Verbal behaviours in this study were investigated from two aspects—dialogic teaching and the utilisation of musical/cognitive/physical-domain descriptors. Although this study found that the majority of timbre targets and teacher's scaffolding were teacher-intended, there was still an open and free space left for the students. The student-initiated dialogue strongly indicated their understanding of the learnt timbre target, such as those of perceptual differences in timbre, gestural controls, relevance to other performance parameters, or the need to seek help. The teachers scaffolded the student's needs and facilitates the communication process by enquiring, listening, and commenting. As claimed by some scholars (Alexander, 2000), a shared conception of piano timbre was constructed through the joint contribution from the teacher and the student.

With regard to the timbre descriptors, this study revealed that timbre targets were described with concrete physical movements rather than musical or conceptual metaphors, images, and emotions in the overall examination of the teachers' verbal instructions. This gives an initial impression that timbre production is highly technique-oriented. However, this result is in contrast with previous studies which have shown that, for example, emotion-oriented descriptions are preferred (Woody, 2000) or that explaining concrete musical results is more effective than physical descriptors (Colprit, 2000) in the teaching and learning of musical expressiveness. Indeed, following a more detailed examination of the categorisation of timbre targets in this study, some interesting trends emerged: descriptions referring to both physical and cognitive domains were fairly well balanced but occurred more frequently than those focusing on musical domains when the teacher was talking about Metaphorical Timbre. The proportion of physical descriptors was specifically high in the cases of Ideal Timbre. Nevertheless, when the teachers referred to the idea of Shaping Timbre, the proportion of descriptions relating to concrete musical results was specifically more frequent than the other two domain descriptors.

This study highlights the importance of language in the communication of timbre goals between university-level teachers and students, which is distinct from several previous studies which indicated that standalone modelling can be effective in music teaching (Rosenthal, 1984; Sang, 1987; Woody, 2006). Meissner and Timmers (2020) mentioned that the student's age influences the amount of talking by teachers and also that teaching musical expressiveness to young children faces the difficulties of 'turning verbal teaching into actions'. The student participants in this study are university-level students, but still face the challenges of understanding the teacher's verbal instructions about Metaphorical Timbre (e.g. darker timbre was interpreted as playing slower by the student in Pair B, but this was rejected by the teacher). However, this study would suggest that teachers and students take advantage of conversation and verbal instruction within piano lessons. Timbre goals leave an open space for both the teacher and the student to

explore, in which the intentionality and meaning can be co-constructed and within which language plays an important role in terms of achieving a shared understanding of playing techniques, timbre metaphors, perceived/felt emotions, bodily sensations, and imageries. Musical experiences of both the teacher and the student can be enriched using self-regulation and sensorimotor coupling (Schiavio, 2019).

9.9.4 'Get beyond the notes' – Multimodal and embodied approaches to teach and learn timbre concepts

This study indicates that the teachers asked their students to feel piano timbre by using all of the senses, not just hearing. Modelling was regularly used as teaching strategy in this study; however, in addition, the understanding of timbre targets came from the contributions of other sensory modalities such as physical touch, gestural visualization, metaphorical expression, and proprioception. This study has found that non-verbal behaviours in teaching and learning of piano timbre meet the technical needs of students, with the teacher demonstrating the right sound-producing actions, and adjusting performance gestures and posture. These behaviours also work effectively to meet the proprioceptive needs of the student in the focus on timbre, which is in accordance with previous studies (Zorzal & Lorenzo, 2017), in terms of learning where and how much the weight comes from, the movement speed and lightness; and the learning of haptic experiences required to play the piano (Simones et al., 2015). All these elements helped to create a shared, multidimensional, space for both the teachers and students to understand and explore the possibility of performed sounds – therefore there is a need to 'get beyond the notes' (Davidson, 1989; Barten, 1998). In the cases of Metaphorical Timbre, the communication of piano timbre is relies on a link with emotional expressions, internalized movements and images, and cross-domain experience evoked by analogies. Timbre is no longer a 'hardwired' sonic feature of a musical piece, but is deeply rooted in bodily experience and feelings, and which, in turn, enriches the conception

of piano timbre for both the teacher and the student and brings more expressive qualities to timbre itself.

Figurative language and vivid metaphors occurred frequently in the cases of Metaphorical Timbre, but they were made concrete and explicit through the use of motion-related descriptions. For example, the analogy of the finger as a dragonfly that passes through the surface of water, helped students to grasp the motor-kinaesthetic features needed to produce a light timbre. This is similar to Barten's study (1998), where a flute teacher instructed the student to keep an open throat by asking him to imagine a hot potato in his mouth. This study has found several instances where metaphors and real-life examples have been used successfully by teachers to explain inaccessible procedures such as performance. By using such motion-related descriptions, a shared motor-kinaesthetic experience relating to weight, direction, tension etc. can be communicated to the students, to help them produce an implicit timbral effect. These results imply that timbre targets are not just based on sonic effects, but, rather, are of an embodied experience.

A close mind-body integration is evident in the learning of timbre goals. The teachers helped the student to continuously refine the performative gestures where sound is the ultimate goal. This forms a perception-action recycle (Godøy, 2011): the bodily movements and sensations contribute to the experiences of the tone production process, meanwhile performance actions and gestures are adjusted and driven by an auditory anticipation (e.g. a desired timbre or a 'richer' timbre). In this action-perception loop, the teacher actively guided the student's attention to either sound, intentionality, gestures, or bodily sensation, to help the student to connect the body and mind, and to integrate gestures with intentions. An embodied perspective on musical learning seems justified so that motor skills related to timbre production are gained through sound discovery in the interaction with the piano (Schiavio et al., 2017).

9.9.4 Implications for piano teaching practice

Prior to this study, I acknowledge that I thought that the knowledge about teaching piano timbre must have had many practical examples, and that piano teachers were capable of adopting different teaching strategies for individual students. However, the imagined richness of studying teaching in practice is not in accordance with the fact that the teaching and learning of piano timbre has been rarely studied in empirical musical studies. The important findings from this thesis, that I want to communicate with piano teachers, are NOT the types of playing techniques that were reviewed in the theoretical chapter and corroborated in this study; but rather I want to stress the gap in the conceptions of piano timbre between teachers and the students, and between students with different performance levels. I would suggest that piano teachers should focus on enhancing the awareness of varying piano timbre and the cultivating the sensitiveness of feeling of timbral difference from the earlier stages of piano teaching and learning. A mixture of language, dialogic teaching, and non-verbal strategies should be used in the teaching and learning of timbre targets.

In terms of language, metaphorical descriptions help to build a bridge and construct cross-domain mapping between abstract timbral experience and concrete physical experience. ‘A lute-like sound on the piano’ is understood in terms of percussiveness, finger release, and note sustaining. Powerful metaphors are impressive and long-lasting, and therefore can enable a higher and broader cognitive function that will be manifested in further performances. Explanations relating to musical results help the student to build an explicit performance plan when producing timbral nuances on a broader level and larger scale. This type of language, together with the teaching strategy of modelling, effectively projects images onto the student’s short-term memory and guides their normal practice. Motion-related description is fundamental in the teaching and learning of piano timbre, and forms the roots of the understanding of timbral concepts. With respect to the use of dialogic methods, piano teachers should be encouraged to be aware of the fact that timbre targets are indeed hard to understand and to communicate compared to other

performance targets (e.g. dynamic, timing), but that there can be co-constructed conceptions of both teachers and students by encouraging more participation from students. Instead of mere imitation, instruction on proprioceptive feelings help the students to connect their movements with more interoceptive feelings and mental activities. The body language, makes the implicit and uncompleted verbal expression more explicit, accessible, and understandable.

9.9.5 Summary, limitations and future research

This thesis found that the teachers preferred to name timbre goals as a metaphorical (e.g. men's voice, brighter sound etc.) or an ideal type (e.g. right timbre). Nevertheless, further examination of the verbalization and communication showed that these timbre goals were explained more frequently using descriptions of physicality, instead of in terms of musical outcomes, emotions, or imageries, thus implying that the meaning of timbre goals is enacted through real-time bodily experience and embodied performance gestures. Dialogue and non-verbal gestures contribute to the teachers' and students' sharing of a conception of timbre goals, where shared proprioceptive knowledge is at the heart of the communication rather than teacher modelling. I argue that these results challenge the ideas of 'teacher-centred' teaching process and suggest the adoption of an embodied and multimodal perspective on the teaching practice of tone production.

The first limitation of this study is the study design: it is not purely phenomenological but mixed with observational approaches; it is also not an entirely observational approach but was influenced by the employment of dialogic teaching in the third week; and it is not a true action-research, since the length of observation duration was too short. The teachers changed their behaviour by asking more open-ended questions in the third week but the observation did not last long due the conflicts with their ordinary teaching routines. The reason is due to the exploratory aim of this study; future research will focus on aspects of the factors mentioned above, to give more systematic examination results.

In addition, this study only observed three pairs of teacher and students in a HE context. The time allocation in these piano lessons is hard to generalize in terms of its relationship with student's performance level and teacher's experience. Interesting results may arise when comparing a variety of teachers, for instance novice-teacher, student-teacher, and expert-teacher regarding the amount of time devoted to timbre and types of verbal instruction (e.g. Goolsby, 1997). Further work could also be developed in the field of cross-cultural comparison (e.g. Bonastre, Muñoz, & Timmers, 2017; Benson & Fung, 2005), to compare the differences in the conceptions and approaches between music teachers from different cultures. In addition, this study only considered the teaching and learning of piano timbre in a higher-education context. Future teaching observation studies could include student participants of different ages and backgrounds, for instance, music conservatory students, junior-students, and amateur musicians, to investigate how teachers adjust the scaffolding approaches to students' performance level (cf. Simones et al., 2015; Burwell, 2006).

Chapter 10: Conclusion

10.1 Introduction

This chapter will summarise and discuss the main findings in this thesis around the following four main research questions. It will look back at the origin and development of research ideas and make a connection between theoretical findings (C2-5) and empirical findings (Chapter 6-9). Q4 answers higher-level questions and aimed to put the study of piano timbre into a broader theoretical and philological context. Main contributions, implications, and limitations of this thesis are discussed at the end of this chapter.

Q1: How is the notion of piano timbre conceptualised?

- How do pianists understand the notion of piano timbre?

- How is timbre referred to in a piano lesson?

Q2: How is piano timbre communicated?

- Do pianists communicate timbral intentions to the audience and is the communication reliable?

- What do listeners perceive in the communication of timbral intention in a piano performance?

- What is the relevance of the auditory and/or visual component of music performance in timbre communiation?

Q3: How piano timbre is taught and learnt?

- What is the process like in a piano lesson, in terms of time allocation and teacher-student behaviours?

- How do different teaching strategies work together to facilitate the communication process?

Q4: What is relationship between body and mind in the perception and production of piano timbre?

10.2 The Conceptualisation of Piano Timbre

(In correspondence with Q1: 'How is the notion of piano timbre conceptualised?')

As mentioned in the introductory chapter, to define what timbre means for pianists became the origin of my PhD research. The motivation to go into further depth was formed by two factors: the contradictory views between acousticians and musicians (Section 2.1.3) and the puzzle of the definition of timbre itself (Section 2.5.5). The theoretical findings relating to the conceptualisation of piano timbre have been summarised below.

Pianists are aware of the fact of limiting timbres on the piano and have an objective understanding of the influence of instrument mechanism and touch quality on tone production. However, the understanding of piano timbre in pianists has already exceeded such physical dimensions, and the psychological and philosophical aspects of piano timbre have been under-researched: there is a lack of an appropriate approach to investigate piano timbre: from the perspective of the performer, regarding the meaning, the significance, and the employment of piano timbre in a musical context. The study of piano timbre should not only focus on singular piano tones, but rather on a polyphonic musical context. This means that the real challenge is not to vary the timbre while keeping the intensity consistent, but to create timbral nuances with the utilisation of available performance parameters. The relevance of the choice of timbre to other expressive parameters (timing, dynamics, and articulation), as well as the musical context, are part of the understanding of the notion of piano timbre.

The theoretical findings shed light onto the study of piano timbre, with new perspectives including performers' control of timbre, the hierarchy of timbre and other expressive cues, the relevance of timbre to musical expression, and sound-action relationship. With these points in

mind, this thesis explored the understanding of the notion of piano timbre through interviews with performers, and the observations from real-time piano lessons. These two studies have examined the two sub-questions in the main question, namely: 'How do pianists understand the notion of piano timbre?' and 'What timbre refers to in a piano lesson?'

In the nature of artistic performance, the understanding of piano timbre is inseparable from the interpretation of the musical work and the influence of compositional structures. However, the freedom and creativity of the performer when interpreting the musical piece defines the notion of piano timbre. Pianists conceptualise the notion of piano timbre in a holistic manner – that timbre has been regarded as the sum of the performance parameters but also defined by the original compositional elements such as musical style and structure. This relates to Kivy's (1995) idea of different types of authenticity in musical performance, including composer authenticity (i.e. be faithful to the composer's intentions and wishes) and personal authenticity (i.e. the performer's own ideas about how to reproduce the musical work). As a result of the twin demands of two types of authenticity, the student-pianists in this study indicated their conscious willingness to interpret the classical musical works with creative and varying timbres, and their authority in the interpretation of the piece of music. Timbre production can be regarded as a combination of both types of authenticity and as a collaboration between the composer and the performer (Kivy, 1995), as well as a dialogue with the material and the context (Hunter & Broad, 2017).

This holistic and inclusive approach to timbre does, however, raise the question - Where does timbre end and other expressive characteristics begin? Indeed, the question may arise as to whether all quotes were related to timbre, or whether in some cases, pianists drifted off this topic into other aspects of expressive performance. Holmes (2011) mentioned that timbre is normally listed as the last one of the hierarchy of priorities in the choice of performance parameters, especially for young musicians. However, this thesis suggests that for advanced-level pianists, where such a hierarchy exists, timbre seems to precede the rest of parameters and becomes the

primary impression of perceived piano sounds. Again, the parallel between 'timbre' and 'look' seems to be in line with this idea (Section 2.5.1; Patel, 2008). However, these findings need to be verified in further research. For example, verification of holistic understanding comes from the modelling of the interplay between performance characteristics in the creation of an intended timbre, as Traube and her colleagues have started to do (Traube, 2017).

In addition to the sonic dimension, piano timbre is also a blended concept that results from the coupling between the performative action, imagined images, and the intended sound. Central to the idea of blended concept of piano timbre, is the nature of embodied experience when perceiving and producing piano timbre in pianists. When approaching a timbral intention, a strong association has been established between the proprioceptive sensations and the subjective description of the produced timbre; the kinaesthetic experiences of weight, tension, relaxation, and movement direction is integrated with the experience of piano sounds. The mind is integrated with the body in a synthesised way in the production of piano timbre, that the awareness and consciousness of the performing body work as a basis and criteria to evaluate the fluidity and satisfactory of physical production process.

Through the lens of piano timbre, this thesis highlighted the benefits and values of the intrinsic sound-motion coupling for performers. Deliberate practice and motor trainings have generated strong sensorimotor couplings in timbre perception/production which enriches their subjective experience (e.g. concepts, metaphors), refines the sound-producing/facilitating gestures, and connects the body with the mind (e.g. concentration, precise control). Timbre was considered an important aspect of piano performance, and one that requires full attention and concentration to be realized properly. This concentration involves a strong focus on the quality of the sound of the performance, comparing this to an intended timbre in a continuous feedback loop in the performance process, which causes a continuous interaction between body and mind in the

perception and production of piano timbre. As a result, performers can engage with music performance in a more expressiveness way as a reward system (Leman, 2016).

10.3 The Communication and Perception of Piano Timbre

(In correspondence with Q2: 'How is piano timbre communicated?')

This thesis switched the reader's attention from the acoustic characteristics of timbre to the physicality, embodiment concepts, and movements related to the perception and production of piano timbre, aiming to enrich and widen the understanding and concept of musical expressiveness and communication with sensorimotor accounts. For a long time, the definition of musical expression/expressiveness has been deeply influenced by Seashore's (1938) statement on 'deviation from the score'[7] (see a discussion in Clarke & Doffman, 2014). The shortcomings of this definition and the over-emphasis on the sonic properties of performance have been noted by several scholars, for instance leading to a trend of the musical score being the primary ontological focus of music (Doğantan-Dack, 2014) and a disembodied, ahistorical account of musical performance by conceptualising the score as the piece (Clarke, 2004). Accordingly, disembodied perspectives on piano timbre are not rare (as reviewed in Chapter 2). However, this thesis would like to assure that, in the pursue of timbral nuances, musical expressiveness is imprinted in the subtle control of gestures, touch, and inner bodily sensations by pianists, as if 'touch is the expressive skeleton on which the pianist enfolds the expressive flesh' (Doğantan-Dack, 2014, p. 7). Touch, gestures, bodily movements and sensations in piano playing contribute to a performer's deeper understanding of abstract concepts and cross-modal metaphors in relation to timbre (Zbikowski, 2008), and actively shape a listener's musical experience.

[7] which defines expression as a deviation from the notated values (i.e. pure tone, true pitch, even dynamics, rigid rhythm etc.) on the musical score.

The communication of piano timbre may be regarded as a meaningful event between the performer and the listener who associate gestural intentions as related to the production of timbral nuances. The communication process does not merely follow the model of 'information-processing'. Instead, listeners actively contribute to the musical communication process, and generate and construct the understanding by resonating perceived messages to their previous knowledge (musical, sensory-motoric, cultural, and educational etc.). Sensorimotor communication happens in the perception of piano timbre, in which timbral intentions communicates more than emotions, feelings, but also proprioceptive and kinaesthetic information, as if the listeners are the performers, by simulating the actions in the head from an onlooker's perspective.

The new insights offered by the theoretical findings have guided empirical studies in this thesis, in relation to aspects including the active role of the listener, sensorimotor communication, and the motivation of creating piano timbre. The sub-questions of: Do pianists communicate timbral intentions to the audience? Is the communication reliable? were firstly explored in the interview study and then demonstrated in the perceptual experiment. The qualitative data implied that pianists have great desire and motivation to communicate timbral intentions to their audience by letting them feel engaged and bring the performer-listener relationship closer; more importantly, this communication process is facilitated by the creative and expressive intentions related to the production of piano timbre and the aesthetic values of timbre concepts. The later perceptual experiment confirmed that piano timbre can be communicated reliably between pianists with equivalent performance levels, and that they showed a certain consistency in understanding and recognition of abstract concepts and metaphorical descriptions of musical sounds.

The next sub-question of: What do humans perceive in piano timbre? has been investigated. The perception of piano timbre is not only an acoustic phenomenon. The responses of the listeners as recorded on the adjective ratings has indicated that they have perceived multidimensional

information apart from the sound input. Why do they perceive such abundant information from the piano sounds? This has to be explained from a first-person perspective which addresses the performer-instrument relationship (O'Modhrain & Gillespie, 2018; Nijs, 2017). The haptic exchange between the instrument and the performer enables pianists to incorporate sensorimotor knowledge at different levels. The understanding of kinaesthetic information of heaviness and lightness, and muscular sensations of relaxation and tension during the production of piano sounds, form the basic level of motor information learnt from interaction with the instrument. More advanced levels of haptic feelings, such as physical shape (roundness/sharpness) and texture (dryness/velvetiness), may occur in more advanced musical training as well as in everyday verbal discourse. However, this thesis does not aim to make a distinction between timbral communication and emotional communication in the piano performance; motion and emotion in musical experience are closely related. Overy and Molnar-Szakacs (2009, 2012) used the SAME (Shared Affective Motion Experience) model to explain the motion-emotion association in musical experience, and noted that: 'musical sounds are perceived not only in terms of the auditory signal, but also in terms of the intentional hierarchically-organised sequences of expressive motor acts behind the signal' (p. 492, 2009).

10.4 The Process of Teaching and Learning of Piano Timbre

The participants in the studies of this thesis were university-level pianists and classical musicians, who may choose piano performance/teaching as their future career or become elite musicians. As Doğantan-Dack (2017) pointed out, classical musicians are facing great challenges and pressures due to the sustainability of the profession itself and the diversity of today's musical genres and practices. On the pathway to becoming an elite performer, the learning and production of piano timbre illustrates the challenges that a pianist might face, such as finger motor control, a high level of mind-body integration, and expressive freedom (cf. Doğantan-Dack, 2017) extending beyond the composer's intentions (as mentioned earlier). Even more than at the beginning stage (i.e.

emphasis on fun leading to skill development) or the specialization stage (i.e. forming an identity as a pianist) of musical learning (McPherson et al. 2012), the student-pianists at the university or music conservatories may experience the multiple pressures brought about by the development of performance techniques, an ever-widening performance repertoire, peer-competition, and public-performance anxiety etc. However, in the process of working on and developing piano timbre in a holistic manner, student-pianists may increase their musical competency (i.e. effective skills needed for timbre production) and a sense of autonomy (i.e. a sense of self-control and expressing own feelings), which may help to fulfil student-pianists' psychological needs at this stage of their musical education and maintain the motivation to persist and engage with music (Wise, James, & Rink, 2017).

This thesis also investigated teacher-student interactions in one-to-one piano lessons, which was discussed in relation to an embodied and enactive account (Elliott & Silverman, 2014; van der Schyff, 2015) of studying music education and music cognition. Several scholars have shown their critical thoughts about traditional perspectives of 'stimulus-response' and 'sender-receiver' to explain the teacher-student interaction (van der Schyff, 2015; Schiavio, Stupacher, Parncutt, & Timmers, 2020). According to the orthodox 'representational, correspondence-based' schema (see a discussion in van der Schyff, Schiavio, & Elliott, 2016), students may rely on pre-existing cognitive mechanisms to respond to external stimuli, e.g. verbal instruction or aural modelling given by the teacher; a task-specific, mental representation is generated followed by a rule-based computation process, which guides further performance plans (Schiavio et al., 2020). However, van der Schyff et al., (2016) criticized this model in terms of leading musical development to a fixed, objective knowledge stored 'in the head'. Schiavio et al. (2020) indicated that the learning outcomes of novices were better in turn-taking mode (participant-participant or participant-computer playing different sections in turns) than the imitation mode (participant solos or duos coping what a computer played), possibly due to actively (co-)participating in the

generation of musical materials, thereby implying that the musical learning process is a shared, in-the-moment, musical experience. The physical experience and real-time interactions happened during the piano lesson help to enact the meaning of timbre concepts and metaphors.

10.5 Mind-Body Integration

By adopting an embodied perspective to investigate the perception and production of piano timbre, the emphasis is placed on the extent to which the body is connected and integrated with the mind in piano practice, listening, and the educational context.

The theoretical findings indicated that the language (not all, but action-related) and concepts related to piano timbre are understood via bodily experience and movements; and that the notion of musical gestures reminds scholars to switch their attention from touch quality to holistic bodily movement. A strong association between timbre perception and performance actions has been established in performers due to mechanism of action-perception coupling, and a shared kinaesthetic experience related to the production of piano timbre between the performer and the listener should exist as a result of mirror neuron system.

The interview study in this thesis has taken the aspects of musical gestures and proprioceptive feelings into consideration. In the production of piano timbre, performers connect a timbre descriptor with the auditory perception (what it sounds like), the visual perception (how the hand/finger positioned), the proprioceptive feelings (speed, weight, force, energy) and muscular sensations (tension, relaxation). The multisensory perception plays a vital role to construct the meaning of timbre descriptors and concepts. The teaching observation study has revealed the process of how language, sound, and the movement work together to understand a concept of piano timbre. In the piano lesson, a metaphorical description of timbre used by the teacher does not only work as ‘messages’ that ‘transmit’ to the student -- the comprehension process is facilitated by the concurrent bodily feelings and the sound.

The adoption of embodied perspective also sheds light on the understanding of the connection and relationship between the performer and the instrument, the performer and the listener. Regarding the performer-instrument connection, the multidimensional experience related to the perception of piano timbre can be regarded as an outcome of meaningful engagement with the instrument. Varela et al., (1991) posits that cognition is essentially a sense-making process and experience and is constituted by a person's meaningful engagement with the external environment. Schiavio et al., (2017) suggests that motoric skills are gained through sound discovery in the interaction with physical environment. The idea that the 'instrument becomes an extension of the performing body' has also been emphasised by several scholars (e.g. O'Modhrain & Gillespie, 2018). This thesis contributes to the idea of enacted and embodied cognition, with new understandings of how the sensory and motoric skills gained through interacting with the piano enriches the conceptualisation of piano timbre. The dynamic sound-action coupling process and proprioceptive feelings during performing integrate the performer with the instrument, closes the feedback and feedforward loop, and breaks the separation between the performer, the keyboard movement, the hammer stroke, and sound generation. Performers are connected with listeners not only because the strong emotional responses resulted in timbral effect, but also a shared understanding of the sound-gesture relationship – in a sense that performers are listeners, but listeners are also be performers.

An extending question raised by this thesis is: Are the different timbral features in performed piano tones a purely imagined and subjective experience for the performers? Given the results of the first interview study, and the comment that, 'a moving gesture makes moving sounds', some scholars might conclude that such a view of piano timbre is subjective and individual, and that it lacks a scientific explanation. However, the findings of the perceptual experiment demonstrated that pianists showed a certain consistency in understanding and recognition of abstract concepts and metaphorical descriptions of musical sounds. It has been assumed that

pianists are likely to use similar strategies to conceptualise the timbre descriptors (e.g. round/sharp, heavy/light, etc) including those of mental images, emotional associations, concrete musical results, and embodiments (gestures, facial expression, movements etc.). Meanwhile, the teaching and learning of piano timbre have been shown to emphasise on these physical, musical, and mental skills. Therefore, abstract and implicit concepts related to piano timbre are NOT purely subjective and imaginative, but can be shared and communicated successfully via sound and/or body.

10.6 Limitations

Firstly, this thesis has largely adopted a subjective and interpretative perspective to investigate piano timbre but is lack of a great number of objective measurements, which is a main shortage in this thesis. Only one perceptual experiment had been conducted to verify the communication process of the ten distinct timbral qualities expressed by the pianists; however, more objective investigations can be done in the future to understand the performance and conceptualisation process, from aspects such as gesture analysis of the performer (e.g. motion capture devices), sound analysis of produced timbral nuances (e.g. MIRtoolbox), and measurements of muscle activity during piano playing (e.g. EMG).

Secondly, this thesis has investigated the understanding of piano timbre from various perspectives (first-, second-, third-person points of view) but with limited samples in the individual empirical study. Especially in the observation study, the results of time allocation and TS interaction pattern is hard to generalise the relevance to the students' performance levels.

Thirdly, this thesis acknowledges the potential for cross-cultural differences in the understanding of piano timbre concepts, although it did not specifically examine these or found specific evidence for them. Carrying out the first interview study in UK while the third observational study was in China gives two perspectives, but in a way that are not directly comparable. As mentioned earlier in Chapter 5 (section 5.4), the two countries have different traditions for piano performance, which may lead to unique metaphorical descriptions of piano

timbre in these cultures. The analysis of the interview study and the observational study both relied heavily on qualitative data, but this thesis failed to do a systematic analysis or comparison between two countries (e.g. cross-cultural differences in timbre metaphors or performative gestures). Future research may consider cross-cultural aspects of piano performance and education.

10.7 Main Contribution

Contribution 1: bridging science and art

The distinct views of piano timbre between scientists and musicians has caused a divergence in the study of piano timbre, that acousticians focus on examining the physical properties of the sound that influence the timbre, while pianists are more concerned with playing techniques and expressive intentions to vary the timbre - these two camps are lack of communication. This thesis connects existing studies by creating a bridge between different perspectives and approaches in the study of piano timbre. It emphasises on the employment and significance of piano timbre in the artistic context, but also offers valuable insights into scientific and philosophical explanations such as action-perception coupling, cross-modal associations, and mind-body integration etc.

Contribution 2: Adding embodiment to timbre

This thesis has considered piano timbre beyond the scope of the sonic dimension, with more considerations of the role of the body in the conceptualisation and communication process of piano timbre. In this sense, timbre becomes a concept that connects the sound, the body, and the mind. The embodied account of piano timbre in this thesis has been explained both theoretically and empirically around several core concepts include: gestures, proprioceptive feelings, bodily awareness, and consciousness.

Contribution 3: multi-methods, and first-, second-, third-person point of view

Piano timbre has been investigated from first- (interview study), second- (perceptual study), and their-person (observation study) point of view in this thesis. It is evident, that the concept of piano

timbre is equally important in each perspective and the research findings connect well. There is a close sound-gesture association in the conception of piano timbre from the first-person point of view, which makes contribution to the richness in the embodied and cross-modal experience of timbre from the second-person point of view. From the third-person point of view, the role of language is vital in terms of achieving a shared understanding of abstract concept and communicating sensory-motor experiences in concrete and explicit terms. This thesis also brings together the research methods in distinct research fields such as interview-approach in music performance studies, observation-approach in real-time teaching context, and experimental approach to verify the music communication process.

Contribution 4: timbre as a holistic and multi-sensory notion

Referring back to the definitions and concepts of piano timbre, this thesis seems not make contribution to define what piano timbre actually means in the music performance and educational context; however, it points out the multi-factor that contributes to the understanding of piano timbre. Piano timbre is a notion that pianists use to represent their holistic experience of performance parameters but is superior to other parameters and characterised with multi-sensory experiences; It is a blended concept in which sonic outcomes are closely coupled with intentions, gestures, language, and bodily sensations.

Contribution 5: timbre as a lens to study music expression and communication

Compared to the role of timing and intensity, the expression and communication of timbre in music performance studies has been under-researched. This thesis has revealed the richness of the motivations and approaches in which pianists utilise timbre to realise expressive intentions, the effectiveness of the communication of timbral intentions between pianists and an audience, and the significance of teaching and learning timbre targets in piano lessons. More attention needs to be paid to the role of timbre as a lens to study music expression and communication.

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Appendix 1

Information Sheet for Study 1 (interview study)

You are being invited to take part in an interview for a research study exploring pianists' concepts of piano timbre during the expressive musical performance. Please take time to read the following information and decide whether or not you wish to participate. Please also ask the researcher if you would like more details about the research. Thank you for taking the time to read this information.

The Project

This research aims to explore the understanding and concept of 'piano timbre' among expert pianists, which forms a part of researcher's PhD research project.

Why have I been selected to be involved in this project?

You are being invited to take part due to your expertise in piano performance or teaching experience which meets the requirement of participation in this research (ABRSM grade 8 or equalized).

What are the interviews about?

The researcher will ask you several questions around two aspects varying from broad topics to concrete questions. The first part focuses on your general understandings of 'piano timbre' in your performance/training experience; the second part contains more concrete questions, during which you will be asked to play on the piano to demonstrate your explanation. The interview will last between 45 and 60 minutes. You do not need to share anything you prefer to keep confidential.

Will my participation in this project be kept confidential?

Yes. All the information that we collect during the interview will be kept strictly confidential. We will record the interview with a digital camera. These files will be recorded digitally and stored as digital files in password protected folders on researcher's laptop. Your personal information such as facial images and name will not appear in the final report. We will identify each participant anonymously by referring to the abbreviation of first name and family name in our report (e.g. SL refers to Shen Li). The audio files will then be deleted.

What will happen to the outcomes of the pilot study?

Key themes and excerpts of the interview discussions will inform a written report as a part of researcher's first year PhD upgrade report. It is also anticipated that initial findings will be presented at future potential conferences and publications.

Appendix 2

Interview Schedule in Study 1 (interview study)

The first part: Pianists are asked about their general opinions and understandings of piano timbre concepts:

(1) Can you explain to me how you understand the notion of piano timbre?

(2) What other terms do you use to replace 'timbre'? What are closely linked terms for you?

(3) When and on what occasions do you usually talk or think about 'piano timbre'?

(4) How do you create different timbres on a piano?

(5) How important is 'timbre' in your opinion for an expressive piano performance?

The second part: Pianists are asked to illustrate their use of piano timbre in a self-selected musical example. They play the piece and afterwards are interviewed about their intentions:

(6) Can you explain what your expressive intentions are with this piece of music, focusing on the timbres / different sound colours that you would like to produce?

(7) Can you explain more about how you think about timbre when performing this piece of music? E.g. imagination, conceptualisation

(8) Do you think in terms of different sounds to produce? Or do you also use other sensory modalities to support the timbre concepts? For example, do you think in terms of colour, touch, or gestures?

Appendix 3

Information Sheet for the Performers in Study 2 (perceptual experiment)

*You are being invited to help the researcher to create the experimental stimuli for her listening experiment on '**the perception of piano timbre**'. Please take time to read the following information and decide whether or not you wish to participate. Please also ask the researcher if you would like more details about the research. Thank you for taking the time to read this information.*

The Project

This research aims to explore the role of visual information of musical performance in the perception of piano timbre among listeners, which forms a part of researcher's PhD research project.

Why have I been selected to be involved in this project?

You are being invited to take part due to your expertise in piano performance or teaching experience which meets the requirement of participation in this research (ABRSM grade 8 or equalized).

What are the performance tasks about?

You will be asked to play three musical pieces in **ten timbres (tense/relaxed, heavy/light-weight, bright/dark, round/sharp, and dry/velvety)**. You will be both video-recorded with two HD camcorders capturing your entire body and finger movements separately as well as audio-recorded using the MIDI piano.

The participants in the listening experiment will be presented with your performance in three different ways (heard-only, seen-only, or both heard and seen) and asked to **rate their judgement of perceived timbral qualities**.

More information or questions?

If you would like more information about, or have a concern or question about the project, please contact Shen Li (sli37@sheffield.ac.uk).

Appendix 4

Information Sheet for Listeners in Study 2 (Perceptual experiment)

You are being invited to take part in a listening experiment concerning 'the perception of piano timbre'. Please take time to read the following information and decide whether or not you wish to participate. Please also ask the researcher if you would like more details about the research. Thank you for taking the time to read this information.

The Project

This research aims to explore the role of visual information of musical performance in the perception of piano timbre, which forms a part of researcher's PhD research project.

Why have I been selected to be involved in this project?

You are being invited to take part because you meet the requirements of participants in this study: you are either pianists or non-pianists (but musicians who don't specialize on piano playing).

What are the listening tests about?

In this study, you will either see, or hear, or both hear and see several musical performances given by three pianists. After that, you will be asked to rate your perceptions of the musical performance on several dimension (brightness, relaxation, lightness, sharpness, dryness etc.).

Will my participation in this project be kept confidential?

Yes. All the information that we collect will be kept strictly confidential. Your response will be recorded and then stored as digital files in password protected folders on researcher's laptop. Your name will not appear in the final report.

More information or questions?

If you would like more information about, or have a concern or question about the project, please contact Shen Li (sli37@sheffield.ac.uk).

Appendix 5 (Chinese Translation of Appendix 4)

您好！欢迎您参加**《钢琴音色听力测试》**，请您花一分钟的时间阅读以下信息，如有任何疑问，请向研究者提问。感谢您的参与！

1. 本次研究课题是什么？

探究钢琴音色的感知，以及视觉反馈信息和音乐训练程度在其中的作用。

2. 我在此次听力测试中需要做什么？

您会看到或者听到不同的视频片段和音乐片段，分别是3位钢琴家在用不同的***音色（音质/声音）***来诠释不同的作品。播放完视频（音频）信息后，请根据您所感知到的'音色'，在答题卡上进行答题。一共90个音乐片段，此次测试需要约40-60分钟。

3.我的数据将会被怎样处理和利用？

您此次参加的课题为李申（英国谢菲尔德大学音乐学院）博士课题的一部分，该课题已正式通过谢菲尔德大学人伦研究学院的批准。您的数据将会被记录、保存并分析，最后出现在研究者博士毕业论文的报告中。

4.我的数据将会保密吗？

您的所有个人信息以及答题数据都将会被保密，必要时会以匿名的方式出现在学术报告里。

我同意参加此次研究课题，并配合研究者答题。

签名：_____

Appendix 6

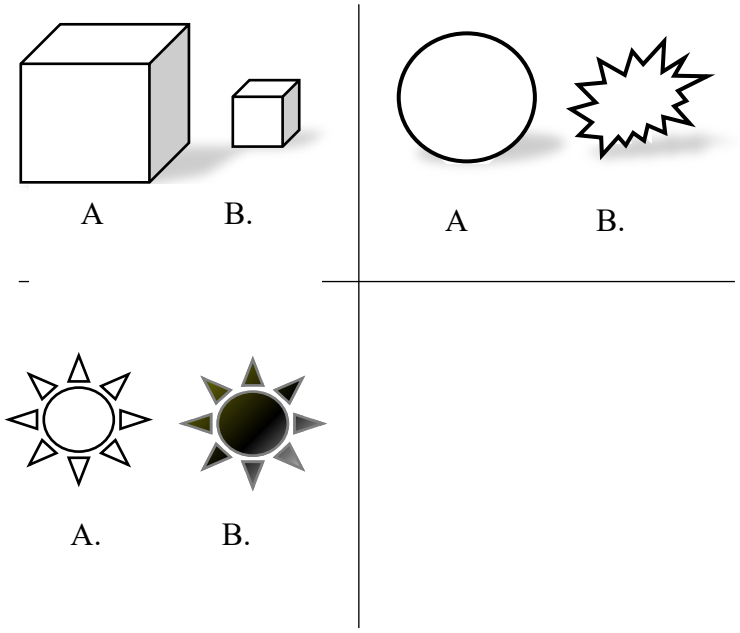
Response Sheet for Listeners in Study 2 (perceptual experiment)

请根据您所听到的音乐/视频片段，回答下列问题*Please listen to the music extract, and answer the following questions*

1. 我认为钢琴家想表达的音色为：*(I think the timbre expressed by the performer is)*

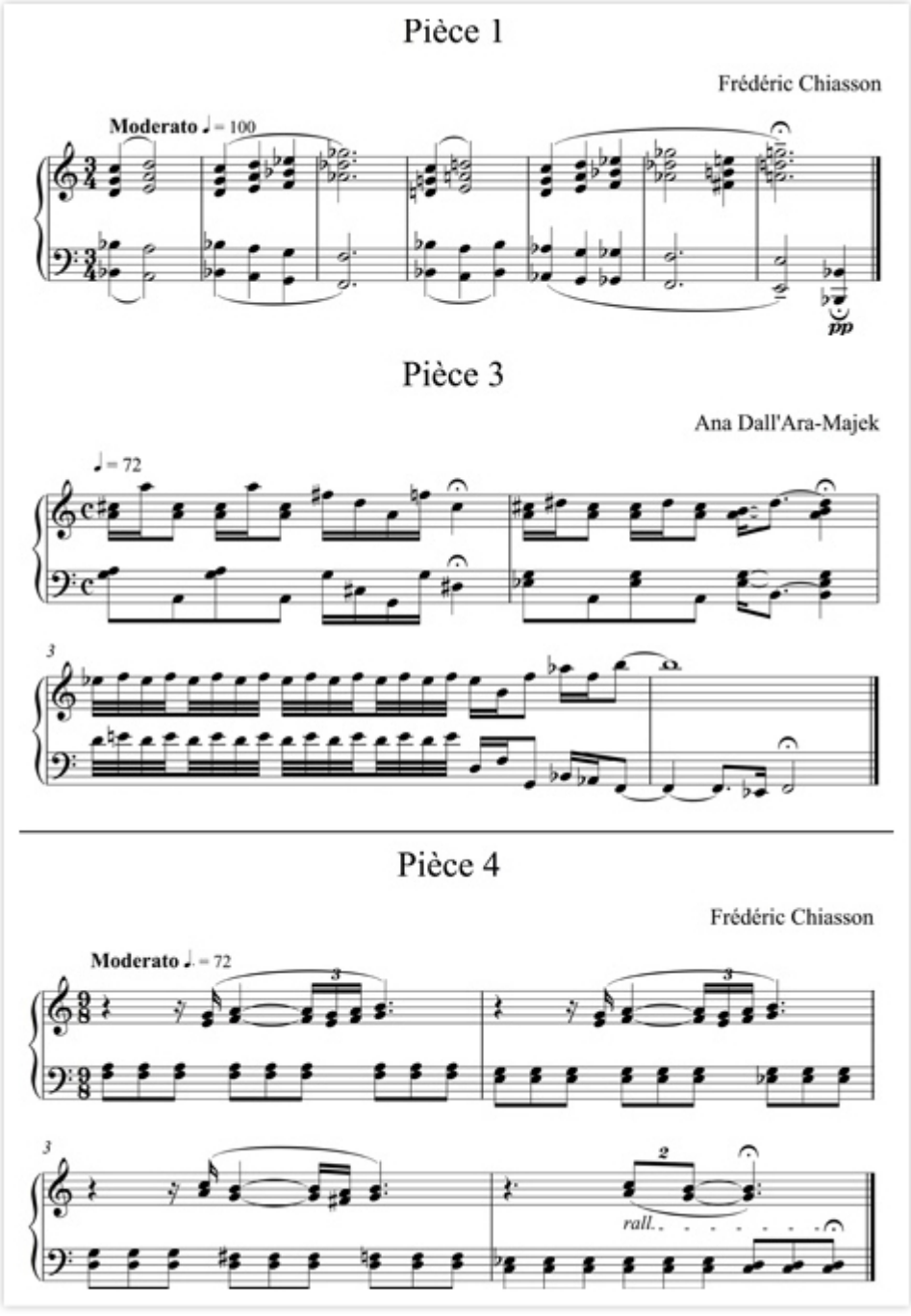
	非常不同意 *Strongly disagree*			适中 *Moderate*			非常同意 *Strongly agree*
紧张的 Tensed	1	2	3	4	5	6	7
放松的 Relaxed	1	2	3	4	5	6	7
轻盈的 Light	1	2	3	4	5	6	7
沉重的 Heavy	1	2	3	4	5	6	7
明亮的 Bright	1	2	3	4	5	6	7
阴暗的 Dark	1	2	3	4	5	6	7
圆润的 Round	1	2	3	4	5	6	7
尖锐的 Sharp	1	2	3	4	5	6	7
干燥的 Dry	1	2	3	4	5	6	7
天鹅绒般的 Velvety	1	2	3	4	5	6	7

2. 我认为钢琴家所诠释的音色，符合下列图像中的这一个：（请在每组中选取一个）*I think the timbre expressed by the performer is in accordance with the figure of: (please choose either A or B in each pair)*



Appendix 7

Music Sheet used in Study 2 (Perceptual Experiment)



Appendix 8

Pre-Questionnaire for Teachers in Study 3 (Observation Study)

This questionnaire aims to explore your general understanding of teaching and learning of timbre in piano lessons. Please rate the following questions:

1. In your opinion, how important is the **teaching of piano timbre** for a good/expressive piano performance?
   (Not at all) 1 2 3 4 5 6 7 (very much)
2. How much **time** do you spend on average on **teaching timbre** when working on a new musical piece?

	Not at all	A little	Moderate	A lot	Most of the time
At the beginning	☐	☐	☐	☐	☐
In the middle	☐	☐	☐	☐	☐
At the end	☐	☐	☐	☐	☐

3. To what extent are the **listed variables** relevant to your **timbre teaching**?

	Not at all			Moderate			very much
Metaphorical descriptions	1	2	3	4	5	6	7
Gestures, hand movement and bodily posture	1	2	3	4	5	6	7
Performance timing, dynamics and articulation	1	2	3	4	5	6	7
Muscular tension	1	2	3	4	5	6	7
Touch weight	1	2	3	4	5	6	7
Touch direction	1	2	3	4	5	6	7
Emotion of the music	1	2	3	4	5	6	7
Musical structure (texture, harmony etc.)	1	2	3	4	5	6	7
Teacher's instructions	1	2	3	4	5	6	7
Student's understanding	1	2	3	4	5	6	7
Student's ability	1	2	3	4	5	6	7

4. Please choose **2-3** descriptions from above, and **explain with examples** why they are important to your timbre teaching.

5. Regarding the teaching of timbre, what would you like to say most?

_____

_____

Pre-questionnaire for teachers in study 3 (Chinese translation)

请回答下列问题：

1）在你看来，**音色的教学**对于一个好的有表现力的钢琴表演来说有多重要？

(一点也不) 1 2 3 4 5 6 7 (非常)

2）在教授一首新的音乐作品期间，您平均花多少**时间**来教授**音色**？

	一点也不	一点点	适中的	很多的	几乎全部
开始阶段	☐	☐	☐	☐	☐
中间阶段	☐	☐	☐	☐	☐
最后阶段	☐	☐	☐	☐	☐

3）下列的表述中，你认为它们在**多大程度**上和您的**音色教学相关**？

	一点也不			**适中**			**非常**
比喻性的描述	1	2	3	4	5	6	7
手指活动，身体姿势姿态	1	2	3	4	5	6	7
演奏音的长短和强弱，断奏与连奏	1	2	3	4	5	6	7
肌肉的紧张度	1	2	3	4	5	6	7
触键的重量	1	2	3	4	5	6	7
触键的角度和方向	1	2	3	4	5	6	7
音乐的情绪	1	2	3	4	5	6	7
乐曲结构（织体，调式，和声等）	1	2	3	4	5	6	7
教师的指示	1	2	3	4	5	6	7
学生的理解	1	2	3	4	5	6	7
学生的演奏能力	1	2	3	4	5	6	7

4）从以上表述中选择2-**3**个相关因素，给予**解释并举例**说明它们如何与教授音色相关：

5）关于**音色的教学**问题，你最想说的什么？

_____

_____

Appendix 9

Pre-Questionnaire for Students in Study 3

This questionnaire aims to explore your general understanding of teaching and learning of timbre in piano lessons. Please rate the following questions:

1. Is it possible for you to make changes on piano timbre in your performance?
   Yes ☐ No ☐

   And why? _____

2. In your opinion, how important is the **learning of piano timbre** for a good/expressive piano performance?
   (Not at all) 1 2 3 4 5 6 7 (very much)

3. How much **time** do you spend on average on learning **timbre** when working on a new musical piece?

	Not at all	A little	Moderate	A lot	Most of the time
At the beginning	☐	☐	☐	☐	☐
In the middle	☐	☐	☐	☐	☐
At the end	☐	☐	☐	☐	☐

4. To what extent are the **listed variables** relevant to your **timbre learning**?

	Not at all			Moderate			very much
Metaphorical descriptions	1	2	3	4	5	6	7
Gestures, hand movement and bodily posture	1	2	3	4	5	6	7
Performance timing, dynamics and articulation	1	2	3	4	5	6	7
Muscular tension	1	2	3	4	5	6	7
Touch weight	1	2	3	4	5	6	7
Touch direction	1	2	3	4	5	6	7
Emotion of the music	1	2	3	4	5	6	7
Musical structure (texture, harmony etc.)	1	2	3	4	5	6	7
Teacher's instructions	1	2	3	4	5	6	7
Student's understanding	1	2	3	4	5	6	7

Student's ability	1	2	3	4	5	6	7

5. Please choose **2-3** descriptions from above, and **explain with examples** why they are important to your timbre learning.

6. Regarding **learning piano timbre**, what would you like to ask or say most?

_____

_____

Pre-questionnaire for students in study 3 (Chinese translation)

此问卷用于探究关于钢琴音色教学中一些问题，包括您对音色的理解以及在教学中应用，请回答下列问题：

1）你是否能做到在演奏中改变钢琴音色？是 ☐ 否 ☐

为什么？ _____

2）在你看来，钢琴**音色的学习**对于一个好的有表现力的音乐表演来说有多重要？

(一点也不) 1 2 3 4 5 6 7 (非常)

3）在学习演奏一首新的音乐作品的期间，你平均花多少**时间**来学习**音色**？

	一点也不	一点点	适中的	很多的	几乎全部
开始阶段	☐	☐	☐	☐	☐
中间阶段	☐	☐	☐	☐	☐
最后阶段	☐	☐	☐	☐	☐

4）下列的表述中，你认为它们在**多大程度**上和**音色的学习相关**？

	一点也不			**适中**			**非常**
比喻性的描述	1	2	3	4	5	6	7
手指活动，身体姿势姿态	1	2	3	4	5	6	7
演奏音的长短和强弱，断奏与连奏	1	2	3	4	5	6	7
肌肉的紧张度	1	2	3	4	5	6	7
触键的重量	1	2	3	4	5	6	7
触键的角度和方向	1	2	3	4	5	6	7
音乐的情绪	1	2	3	4	5	6	7
乐曲结构（织体，调式，和声等）	1	2	3	4	5	6	7
教师的指示	1	2	3	4	5	6	7
学生的理解	1	2	3	4	5	6	7
学生的演奏能力	1	2	3	4	5	6	7

5）从以上表述中选择**2-3**个相关因素，给予**解释并举例**说明它们如何与学习音色相关：

6）关于**学习钢琴音色**这个问题，你最想问的问题或者最想说的什么？

_____

_____

Appendix 10

Post-interview questions in Study 3 (English version)

>Process:

(***Teacher***) Can you please summarise what you focused on during the past three lessons in your teaching? What were your teaching aims and hopes for the student to learn?
(***Student***) Does this correspond to the main learning points that developed during the sessions for you? What did you learn in particular with respect to timbre?

In terms of timbre…. (***Student***) Were there any **frustrating moments** for you? **What** difficulties have you met?

>Approach: （from general to specific examples）

(Teacher)： Can you explain what strategies did you use to develop the student's learning? Did you use particular strategies to teach and work on timbre?
(Students) Which strategies work for you best? And what worked less well?

>Outcome:

(Student) **How far** did you get in mastering the piece, and **in particular** in developing a rich performance in terms of **timbre**?

(For both teacher and student): What are the most memorable moments for you? What happened?

(Teacher) Any further comments?

Post-interview questions in Study 3 (中文版本)

>过程

（教师）：您能总结一下这三节课中您的教学侧重点在哪些方面？您的教学目的和教学预期是什么？
（学生）：请说一下，你在这三节课中都重点学习到了哪些？那关于音色方面，你有什么心得体会？
（学生）：在这期间你遇到过学习上的困惑吗？都是哪些？

>方法 （从总体来说到具体例子）

（教师）: 您能解释一下您在这三节课中的教学上方法吗？
如果您希望学生达到某种音色要求时，您会用哪些方法引导他们？
（教师）：关于你们之间提到的某些例子（教学难点），您能具体谈谈您的教学思路吗？
您能阐述一下您在教学难点中的具体的教学方案吗？
您在教这个学生中遇到了哪些了教学困难？您又是怎么攻破的？
在您所用的教学方法中，
您觉得哪些是非常更对学生接受的？哪些是学生还不好接受的？

（学生）：那你呢，哪些方法对你来说比较好？哪些不那么好？

>成果

（学生）：经过了这些天的教学和老师的指点，你觉得哪些地方有进步？（技巧 / 理解 / ）在音色方面你有特别的感受吗？那你觉得，为了达到一个丰富多彩的音色的演奏，你还有哪些是可以做的？

（教师和学生）对你们而言，这三节课中最让你们印象深刻，不能忘却的瞬间是什么时候？都发生了些什么？（可以是积极的也可以是消极的）

（教师）：对于这个问题，您是怎么看的，有什么要补充的吗？

Appendix 11

Sample of open questions in the final lesson (teaching observation study)

Please use more open questions in the final lesson. This might help your student to think about timbre (what to achieve and how to do this) and become more aware of the possibility to influence timbre. Here are some sample of open questions. Please choose to use where appropriate.

Type A: Questions asked before playing:

>Which part of the piece would you like to work on with timbre?

>What timbre would you like to create?

>How would you like to do this?

Type B: Questions asked after playing:

>Which part of the piece do you find difficult for working on timbre?

>Why is is difficult? What are the problems?

Type C: Reflections on the teacher's performance or the student's own performance:

>How do you think of my timbre? Any differences have you noticed between mine and yours?

>How do you think of your timbre (compared to last time)? Any changes or improvements?