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Exploring Pianists' Embodied Concepts of Piano Timbre: an Interview Study

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Abstract

From the perspective of acoustics, variations of timbre in piano performances are highly constrained, if intensity and articulation are kept constant. Nevertheless, for pianists, piano timbre is an important feature that is, from their perspective, central to a successful performance. To gain insight into the ways in which pianists understand and use timbre, a semi-structured interview and observation study was conducted with eight MA or PhD level piano students, paying particular attention to the role of the body and bodily movements (i.e., gestures and touch) in timbre concepts. Results indicate that pianists conceptualize timbre holistically: timbre is interpreted as the combined outcome of performance parameters (which is often seen as performer-specific) and seen as connected with musical structure (composer/style-specific). Timbre is made concrete by referring to visual/emotional imagery, sound-producing or -facilitating gestures and bodily experiences. The embodiment of timbre was found to be a prominent theme in the explanations of timbre. Accounts included the interpretation of hands as articulators of sounds, associations between corporeal experiences (weight, tension, relaxation, gravity, and motion) and expected/intended timbral effects, and the need for a strong coupling between body and mind to produce timbral nuances.

Keywords: piano timbre, touch-tone relationship, sound conceptualization, body/mind connection, embodied musical experience, sound-producing/facilitating gestures, timbre metaphors.

Introduction

Traditionally, studies of timbre have often taken a macro-perspective investigating distinctions between timbres of different instruments, and have regarded timbre as that what distinguishes sounds that have the same pitch, intensity and duration, but a different sound color. For instance, psychoacoustic studies investigated the impact of acoustic structure (such as spectral energy distribution) on the perception of timbre (Rasch & Plomp, 1982). More recently, interest has turned toward the micro-perspective of timbre (e.g. timbres of an individual instrument) to investigate the influence of playing techniques on the perception and production of timbre, for instance for the clarinet (Barthet, Depalle, Kronland-Martinet, & Ystad, 2010) and guitar (Traube, 2004). We will continue this latter line of research, by considering the interaction between performer, instrument and sonic outcome in the context of piano performance.

A few studies have started to explore timbre in piano performance. Acoustic and psychoacoustic research on piano timbre has been focused on investigating whether pianists have demonstrable control over piano timbre, as observed from acoustic evidence (see a review by Goebl, Bresin, & Galembo, 2004). This approach emphasizes objective measures of sonic outcomes, disregarding how performers approach, conceptualize, or use piano timbre. In contrast, linguistic approaches to the study of piano timbre provide insight into the prevalence and characteristics of conceptualizations of piano timbre in pianists' mind. In music practice, pianists persist in the development of playing techniques to produce varying timbral effects and consider timbre as a central feature of performance elements. Evidence can be found in the views of famous pianists who believe the learning and teaching of timbral nuances has great importance in piano pedagogy (Neuhaus, 1973; Rosen, 2002).

These contrasting perspectives generate an interesting paradox: although pianists have limited control over timbral aspects of their instrument, the idea of producing timbral nuances features strongly in piano pedagogy and practice. A reconciliation of this paradox may be

offered by the inclusion of the body, instrument and sound into the notion of timbre outcomes. In other words, adoption of an embodied perspective on piano timbre is necessary to understand how timbre is conceived and produced by pianists, and what the relevance is of timbre for piano performance. In accordance with previous research, the adoption of an embodied perspective helps us understand the close coupling between body and mind in instrumental performance, including in piano playing (Friedberg, 2002; David, 1996), and musical development (Elliott & Silverman, 2012). By studying the performing body (e.g. Holmes, 2011; Doğantan-Dack, 2011) and the interaction between the body and instruments (e.g. Nijs, Lesaffre, & Leman, 2009), researchers can gain a deeper understanding of the connections between embodiments and abstract metaphors (Zbikowski, 2008) and the interpretative and expressive intentions of performers (Davidson, 2005; Caruso, Coorevits, Nijs, & Leman, 2016).

This research aims to explore how pianists understand and conceive piano timbre and how they realize timbre changes in piano performance. We will adopt a qualitative approach rather than a psychoacoustic or psychometric perspective to uncover key ingredients and dimensions of pianists' understanding and approaches to piano timbre. We specifically expect to identify an important role for the body and different sense modalities, such as touch, in timbre conceptualizations. The piano affords the opportunity to study timbre from a conceptual and embodied perspective due to the conflict between the physical evidence of limited timbre differences and the reality of timbral effects for pianists. Timbre exists in the interaction between performer, instrument, gestures, conceptualizations and sound.

To give further background to this research we will firstly introduce the findings in acoustic and psychoacoustic studies, followed by findings of linguistic studies and main arguments from piano performers/educators. We will argue that these perspectives have too much separated mind and body, focusing either on produced outcomes or on linguistic

conceptualizations. A brief summary of embodied perspectives on timbre studies follows, which has inspired the focus of the present study on the integration of mind and body.

Acoustic/Psychoacoustic Perspective on Piano Timbre

Piano timbre has been studied from a scientific perspective since Ortmann's work *The Physical Basis of Piano Touch and Tone* (1925), whose significance and contribution to studies of piano performance has been pointed out by several subsequent researchers (Goebl, Bresin, & Galembo, 2004; Seashore, 1937). Since then a much-debated question arose regarding whether or not a pianist's touch can change the produced tone quality – i.e. touch-tone relationship. Ortmann (1925; 1935) and other scientists (e.g. Turner, 1939) claimed that the independent control over tone quality is non-existent; pianists can hardly vary the piano timbre independent of its intensity, and intensity is always associated with tone quality. Later on, researchers have in fact been able to demonstrate some control over the produced piano tone through variations in piano touch. Goebl et al., (2004) showed that pianists can distinguish sounds of equal dynamic level produced by two types of touch: struck or pressed. The acoustic analysis of piano tones indicated that the timbral difference relates to the attack noise, with bigger attack noise in struck tones compared to pressed tones (Goebl et al., 2004). A subsequent study (Goebl, Bresin, & Fujinaga, 2014) also found that musicians were able to discriminate between whether a tone reached the bottom of the keyboard, or not, when other physical attributes (hammer velocity, pitch, and duration) were kept constant. With careful experimental manipulations, researchers identified several factors that influenced the touch-tone relationship. This is in line with the emphasis on the importance of touch in piano pedagogy and practice literature. The research of Goebl and colleagues was concerned with the perception of single piano tones. The perception and production of piano timbre in a musical context is more complex, since it might be influenced by the musical material itself as well as by a pianist's utilization of touch and gesture. These studies did not consider the expressive intentions of the pianists, nor how

production, perception and conceptualization of timbre may be related. A separate body of research has focused on investigating pianists' conceptual understanding of timbre, as discussed next.

Conceptualization of Piano Timbre

Metaphors and cross-domain linguistic references are frequently used in teaching contexts and writings about expressive piano performance (Barten, 1998). For example, Bellemare and Traube (2005) assembled a list of 100 timbre descriptors from the existent literature. Using cluster analysis of familiarity and similarity ratings, Bernays and Traube (2011) identified five groups or subsets of descriptors. The five descriptors that best represented each subset were: bright, dark, dry, round, and velvety. Kojucharov and Rodà (2015) collected pianists' adjectival descriptions of touch and timbre, and categorized their responses into five domains: physical-motor (fingers/arms), articulatory (legato/staccato), sensory (heavy/light/soft), emotional (relaxed/tender/powerful), and aesthetic-stylistic (Baroque/beautiful/modern), implying that timbre descriptors are not often linked with sensorimotor activities. This study found that touch descriptors were equally distributed into those five domains, while *timbre* descriptors exclusively fell into the sensory, emotional, and aesthetic-stylistic categories, suggesting that timbre is associated with expressive intentions and outcomes, distinct from the manner of production.

A relatively disembodied perspective on piano timbre is also present in the writing of several well-known pianists, who emphasize the link between concept and sound with little attention to the connection between actions and perceptions. Berman (2002) associated the notion of piano timbre with the sound of a musical piece. He suggested that the stylistic awareness with which a performer interprets a musical piece determines the appropriate choice of tempo, rhythm, phrasing, and articulation, and mental awareness or image has greater importance than playing techniques in achieving a proper sound for that piece. This places the

timbral outcome as the primary element and physical movements as secondary. According to Rosen (2002), it is not uncommon for musicians to regard the musical mind as a higher, advanced organ than the body and to believe that interpretation, conceptions, and imaginations can work independently of the physical body (famous examples include Berlioz and Mozart, who state their prejudice against using the piano when composing). Furthermore, Danuser (1992) identified different strands or cultures in musical interpretation that differ from each other in terms of the balance between reliance on performers' subjectivity (e.g. subjective understanding, emotion) and a more objective approach to performance in which e.g. historical research of the context is used to reinterpret older musical works.

These statements emphasize, the mental, internal dimension of musical performance. However, performing is a close enactment of the articulating body in sounds and interpretative ideas (i.e. Leman, 2016; Caruso, 2018). In relatively early work, Kochevitsky (1967) described an action-perception loop in piano tone production, from visual stimuli (e.g. music notation), inwardly heard tones, the anticipation of motor actions; to produced sounds, and sound evaluation. Kochevitsky (1967) highlights the close link between perception and action in piano performance. Such bodily movements are goal-directed, intentional actions (Leman, 2008), where sound is the goal (Schiavio, van der Schyff, Kruse-Weber, & Timmers, 2017).

The approaches focusing on conceptualization and psychoacoustic perception 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 1). An embodied approach to studying timbre examines the coupling between perception and action, as some authors have recently argued and started to explore.

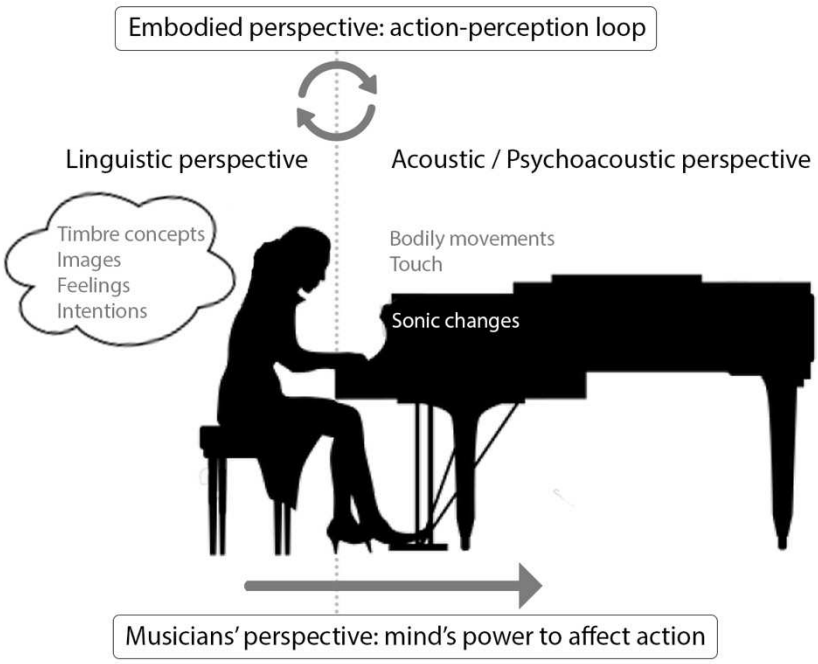


Figure 1: Embodied perspective to study piano timbre.

Embodied Perspectives on Piano Timbre

One of the key notions in embodied cognition is that the human body is actively perceiving the physical world (Varela, Thompson, & Rosch, 1991) and in line with this bodily action shapes human experience (Maes, Leman, Palmer, & Wanderley, 2014). Evidence is found in studies that show an influence of body movements and gestures along with musical stimuli on listeners' perception of musical rhythm, pitch interval, and articulation (Phillips-Silver & Trainor, 2005; Thompson, Russo, & Livingstone, 2010; Quinto, Thompson, Russo, Trehub, 2010) as well as perceived emotional characteristics in music (Maes & Leman, 2013). Moreover, perception of musical sounds may evoke action simulations, specifically in musicians who are proficient on the relevant instrument (Godøy, Haga, & Jensenius, 2005; Hadley, Novembre, Keller, &

Pickering, 2015); Perception-action cycles may arise when perceived and produced sounds cyclically inform each other, fine-tuning and modifying perception as well as production (Godøy, 2011). Embodied cognition theory (ECT) also attributes enhanced meaning to gestures in musical contexts, which blur the distinction between movement and meaning and connect action and perception (Jensenius, Wanderley, Godøy, & Leman, 2010). Musical gestures have been demonstrated to be linked with expressive intentions of performers (Davidson, 1993; 2006) and be constrained by musical structure (Thompson & Luck, 2012).

The distinction between sound-producing gestures and sound-facilitating gestures (Jensenius et al., 2010) is relevant for the understanding of timbre-related bodily movements. Different types of piano touch for example (MacRitchie, 2015; Berman, 2002; Parncutt & Troup, 2002) belong to sound-producing gestures due to their direct relationship to sonic outcomes. However, pianists do not move fingers and hands solely; instead, wrists and arms may move to coordinate finger movements, and head and shoulders may carry communicative intentions to support sound-producing gestures. These can be seen as sound-facilitating gestures. According to Jensenius et al., (2010), "it is the preparatory movements of this complex multi-joint system that determines the trajectory and velocity of a finger before and after it hits the key" (p. 26). Godøy and his colleagues referred to the notion of "co-articulation" (Godøy, Jensenius, & Nymoen, 2010) to describe this complex dynamic of sound-related actions and the characteristics of temporal development (i.e. further gestures shape current gestures) (Godøy, 2013). Therefore, researchers may need to consider timbre-related actions as integrated units in which movements unfold holistically in a temporal and spatial manner.

With respect to timbre perception researchers have started to examine the impact of multimodal experiences that are intrinsic to performance on piano timbre perception. In particular, Parncutt and Troup (2002) proposed that kinesthetic feedback from finger contact with the keys influences a performer's perception of piano timbre (first-person perspective),

while visual perception of a music performance affects the listeners' perception of piano timbre (third-person perspective), e.g. perceiving a hard/brittle tone after watching a pianist aggressively striking the piano keys. O'Modhrain & Gillespie (2018) elaborate on the idea of haptic exchange between the performer and the instrument by asserting that, the piano is an instrument that can not only be driven by the performer, but also can drive the performer. 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. Therefore, a performer's bodily movements affect his/her own experiences of tone quality due to the haptic-proprioceptive feedback from the keyboard and the active interaction with the instrument (Saitis, Järveläinen, & Fritz, 2018). From an observer's perspective, the listening experiment conducted by Schutz and Lipscomb (2007) suggested that the visual information of stroke action (either longer or shorter gestures) in a marimba performance influences the listeners' perception of tone duration. A pianist may also push into the keyboard after the striking of the string, to create an illusion of a sustained tone. These examples illustrate how multisensory modalities may be part of timbre perception.

A few investigations of the role of gesture in piano performance (e.g. Doğantan-Dack, 2011) have suggested the importance of embodied experiences in piano tone production. Specifically, Askenfelt, Galembo, and Cuddy (1998) have suggested that the perception by a pianist 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 forms 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 suggested the importance of initial gestures in shaping the experienced tone quality of a listener, although the listener may not

experience the sound in exactly the same way as the performer, who has additional kinesthetic feedback from the key (2011).

Considering timbre in voice and other instruments than piano, studies have indicated bodily experiences to be part of musicians' timbre concepts and metaphors. In a preliminary pilot study, Prem and Parncutt (2008) asked a jazz singer to rate the degree of corporality of a set of vocal timbre descriptors. A subset of descriptors received high ratings of corporality with 22 of 250 words receiving the maximum rating of corporality. These included words such as: "anchor, articulating, attack, avoiding, constricted, relaxed" (p.70). Larger scale work on timbre perception and production has shown a reference to vowels and associated oral production in the production and conceptualization of guitar sounds (Traube, 2004), as well as saxophone sounds (Nykänen & Johansson, 2003). These studies indicate a close association between timbre descriptors (e.g. thin, round, open, and sharp) and phonetic gestures. The question is how these observations may translate to piano timbre.

The reviewed studies support the proposition that for a performer piano tone and by implication piano timbre are not solely auditory experiences. Instead, the perception of piano tones may be shaped by motor, kinesthetic, and visual experience, and expressive interpretations are embodied in movement, gesture, and touch. This study aims to empirically explore pianists' concepts of piano timbre and the relevance and role of the body and sound-producing and -facilitating gestures (Jensenius et al., 2010), as well as to deepen insight into the ways in which piano timbre is conceived as a multimodal construct (Parncutt, 2013). Our working hypothesis is that pianists make use of various modalities to 'ground' piano timbre and gestures are the primary dimension for this. To address these aims, we will explore pianists' understanding of piano timbre by asking them to describe and demonstrate their approach to timbre in individual interviews. This will be done in an open-ended fashion, avoiding an explicit focus on embodied understanding of timbre to avoid biasing our interviewees.

Similarly, we will not confine results to examples of embodied notions of timbre, but explore the range of perspectives prominent among our interviewees.

Methodology

As concepts of piano timbre for pianists are developed over years of specialized musical training, eight advanced-level pianists (seven female students, one male student; average age = 25.58, SD = 8.24) took part in a semi-structured interview and observation study. They were all postgraduate students in piano performance studies at the Department of Music of the University of Sheffield; six were studying for an MA in Performance and two for a PhD in Performance. They were taught by different piano teachers and came from different educational backgrounds. Interviewing student-pianists is helpful to explore to how and to what extent piano timbre concept is studied and developed as part of higher education teaching and learning, with potential relevance for music education (see also Li, 2020). A pre-questionnaire of musical background indicated that participants had received continuous training in music and had been actively playing the piano since 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).

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 colors and their ideas on the importance of timbre in piano performance (see Appendix).

In addition, pianists were asked to bring a piece of music that they knew well or were studying at that moment (as shown in Table 1). The self-selected music works as a stimulus to

remind themselves the knowledge about mobilizing timbre in piano playing. 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 bodily 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 bodily movements (e.g. subjective experiences, proprioceptive sensations). Therefore, individual choices were considered and there seemed no need for a systematic control of selected musical pieces. 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 musical excerpts carried timbral intentions and what timbres they pursued (i.e. what), how they moved the body or adjusted the gestures to make 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 (i.e. an explicit understanding of timbre based on an unfamiliar performance model) (Caruso, 2018).

Table 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*	Debussy	1908
3	*Etude Op.42 No.5*	Alexander Scriabin	2007
4	*Piano Concerto No. 21 in C major, K.467*	Mozart	1785
5	*1. Piano Sonata in E minor, Allegro Moderato*	Grieg	1865

	2. Poem	Zhang Nan & Zhang Zhao	2007
6	*Piano Sonata in C Major Op.2 No. 3, 1st movement*	Beethoven	1795
7	*Etudes-tableaus, Op. 39, No. 6 in A minor*	Rachmaninoff	1916
8	*Prelude and Fugue in F#, BWV858*	J.S. Bach	1722 or earlier

Pianists were individually interviewed and observed in a single session which took up to one hour. They were firstly interviewed, then asked to perform and give explanations. The session was recorded on video. A scheduled list of questions was used to facilitate the process (see Appendix). The semi-structured interview focused on exploring pianists' understanding and conceptualization of piano timbre. The observation part of the study investigated the physical production of piano timbre including body movements, gestures, and touch in relation to what was said by the interviewee.

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) – using a combination of an inductive approach (data-driven) and deductive approach (theory-driven), 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 (see Figure 2 for a list of pre-existing codes and new codes). 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 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. The coding was carried out by the first author who has a background in piano performance, which enabled inductive analysis with an understanding of both technical and artistic context (Holmes, 2012). The codes were then verified by the second author.

Non-verbal information, including gestures and performances from video recording was also analyzed 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). Images made from the video extracts were compared for gesture analysis when the pianist had different/contrasting timbral intentions in the same musical extract.

Results and Discussion

Six themes emerged from the data analysis using pre-existing codes and the codes from the data as displayed in Figure 2. The first three themes reflected participant's understanding of piano timbre. Pianists held a holistic concept of piano timbre seeing it as closely linked to other musical parameters (Theme 1). Furthermore, timbre was seen as characteristic for specific performers or composers (Theme 2). It was deemed fruitful to draw parallels with other instrumental performances, as well as with visual imagery, movement and feelings more generally (Theme 3). Themes 4-6 present an embodied perspective on pianists' perception and production of piano timbre, with deeper insights into sound-producing and -facilitating gestures. The six themes were divided into two groups as the first related to the verbal explanations of the pianists and the second to the demonstration and explanation of piano timbre. These will be presented in turn, followed by an intermediate discussion.

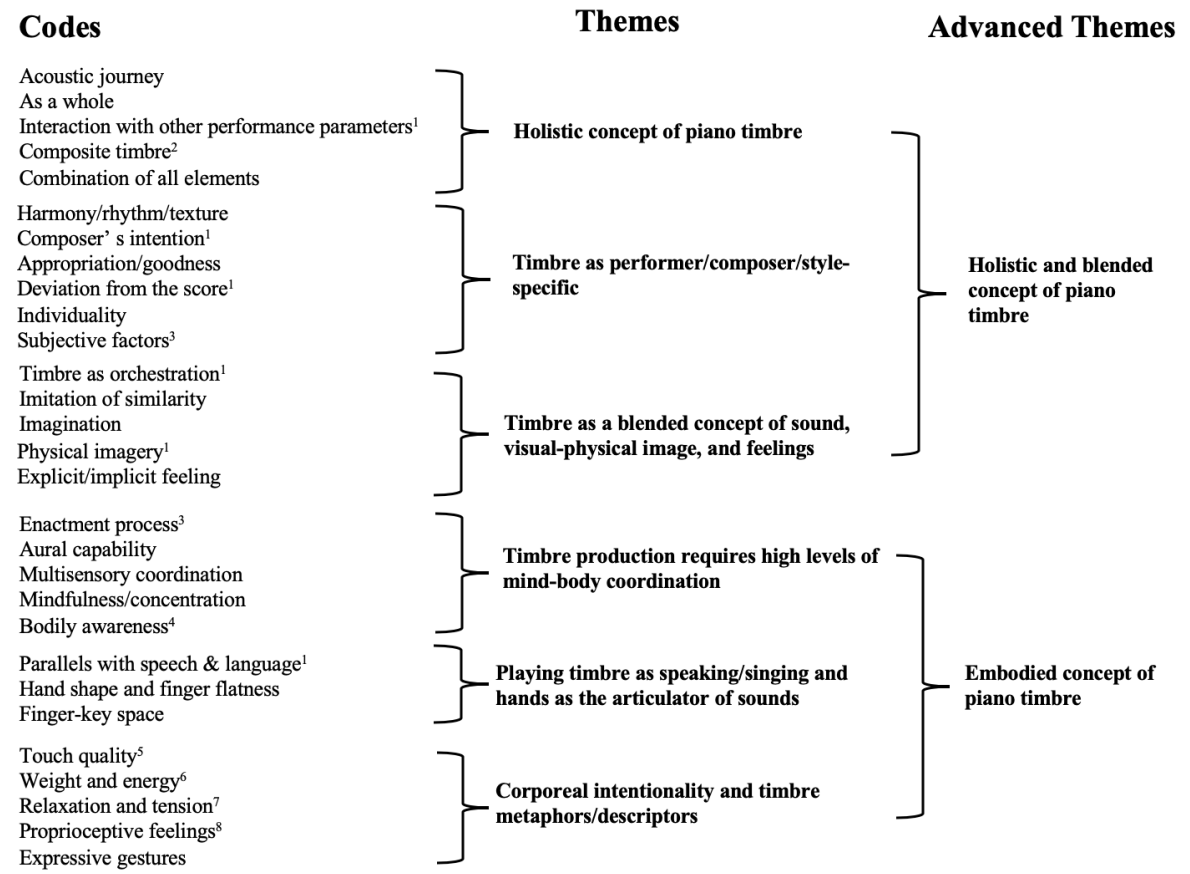


Figure 2: Codes, themes, and advanced themes in this study.

Pre-existing codes: (1) Holmes, 2011; (2) Bernays & Traube, 2014; (3) Caruso et al., 2016; (4) Godøy, 2011; (5) Goebl et al., 2014; (6) McPherson & Kim, 2011; (7) Neahaus, 1993; (8) Fieldon, 1934.

Theme 1: Timbre as a Holistic Concept.

Psychoacoustic studies have shown that perceived timbre covaries with pitch, intensity and sound envelope variation (see a recent review in McAdams, 2018). The interactions between these parameters play a role in the subjective experience of timbre, for instance in the perceptual assessment of tone quality (Marozeau, 2004) or a unified impression on pitch, intensity, and duration variations (Ortmann, 1935). This subjectivity and time-varying feature of timbre perception is amply reflected in this study. 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". This is in line with works by, for example, Halmiton (2012) who associated piano timbre with "the illusion of different hues by dynamic contrasts and shadings" (p .59) and Bernays and Traube (2014) who defined the notion of composite timbre as subtle tone combinations via the expressive use of timing, dynamics and pedaling. 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).

Theme 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. Pianists indicated that their choice of timbres was guided by what they deemed to be appropriate for the composer, genre and work they were playing. Additionally, the pianists were convinced of the individuality of piano timbre: a unique combination of playing technique and musical interpretation gives a distinct and unique sound, in the words of one of the participants - "an individual sound palette" (P3). This relates to Kivy's (1995) idea of different types of authenticity in musical performance, including the composer authenticity (i.e. be faithful to the composer's intentions and wishes) and personal authenticity (i.e. the performer's own ideas to reproduce the musical work). In this study, timbre production can be regarded as a combination of both types of authenticity

and as a collaboration between the composer and performer (Kivy, 1995). 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). The notion of 'timbre as performer-specific' is being tested in an ongoing project of Valière and colleagues[1] using motion capture, which provides a biomechanical explanation of how pianists make a unique timbre that is distinct from each other. Their psychoacoustic study demonstrated that listeners can successfully recognize different timbres of the same excerpt when played by different pianists (Valière, Lefèvre, Colloud, & Villard, 2019).

Theme 3: Timbre as a Blended Concept of Sound, Visual Imagery, Movement and Feelings.

Pianists frequently associated piano timbre with an image, feeling, or gesture. They referred to musical structure and titles to construct relevant imagery. For instance, P1 described the sound 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 the piece "Etudes-tableaus, Op. 39, No. 6 in A minor" (known as 'little red riding hood and the woof'). In both cases, 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 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

[1] https://news.cnrs.fr/videos/the-pianist-and-the-scientists

contrast, dark timbres were related to sad emotions as if "sending the son to the hospital" (by P4). Feelings, visualizations and gestures seemed to be crucial components of the enactment of interpretative ideas as timbral nuances. As found previously, references to experienced emotions may contribute to the expressiveness of a performance (Van, ZijI & Sloboda, 2010) and can be used as expressive performance cues in the practice and memorization of musical pieces (Chaffin & Imreh, 2002).

In line with the prevalence of the idea of "the piano is like a miniature orchestra" in the writing of famous pianists (Rosen, 2002; Berman, 2000), the pianists in this study frequently referred to this idea. Their detailed descriptions of imitations of other instruments gave further support to the notion of timbre as a blended concept combining sound, gesture, and intention. References were made to emulations of strings, percussion, and the voice, for instance with respect to "its register" (P2, P3, P7, and P8), and also the possibility of "imitating and transferring playing techniques of other instruments" (P2). Interesting parallels can be seen with explanations such as Zhao's (2007), who explained the translation of playing techniques of Chinese traditional string instruments to the piano, such as gestures of 'wipe' (use fingertips to slightly wipe the key) and "rotate" (rotate in a circle to imitate a sustaining string sound). The pianists reported that the intention of imitating an orchestral sound may start from the analysis of the composition (i.e. what instruments are implied) and is enhanced by using appropriate touch. Accordingly, pianists said to adjust physical movements and sonic properties (note length, articulation, and dynamic level). P2 explained that, "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." An orchestral sound on the piano offers a rich blended concept of piano timbre, as this process is a blending between actions (i.e. technical similarity) and auditory perceptions

(i.e. sonic similarity), and between expressive intentions (i.e. imitative and interpretative ideas) and corporeal experiences (i.e. bodily movements).

Intermediate Discussion

The holistic perspective that pianists took 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. The extent of this integration goes beyond sounding musical properties only, as becomes clear in the blended concept of piano timbre. 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 conceptualizations 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 become 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.

Theme 4: Timbre Production Requires High Levels of Mind-Body Coordination

In explaining the production of piano timbre, concentration and intentionality came up as prominent themes and the need to create a powerful alignment between body and mind. A state of high concentration was described by pianists as "in the music" (P2), "playing from the heart" (P2); "as if the music is yours" (P5) and as enhanced bodily awareness. This was contrasted

with a less concentrated state, which was interpreted as being "purely finger movement" (P5), "like a robot" (P6), or "absence of mind" (P4). Furthermore, high levels of concentration were required to make timbral nuances and improve pianists' aural sensitivity. For example, P1 indicated the need to "attend audibly to the piece" (P1) and the ability to train your ear to become more sensitive and "hear the difference" (P4).

This need for a concentrated performance effort found parallels in pianists' explanation of the importance of intentionality in timbre production. They 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 about 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 et al., 2017).

Theme 5: Playing Timbre as Speaking/Singing and Hands as Articulators of Sounds

Studies of timbre in guitar and saxophone performance (Traube, 2004; Nykänen & Johansson, 2003) found that musicians draw parallels between instrumental timbres and phonetic sounds (e.g. vowel sounds), which raised the question of whether pianists share similar experiences. We indeed found that a few pianists drew parallels with speech-related gestures when explaining timbre-producing gestures on the piano. 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 3).

> "To me, [playing with flat fingers] sounds a little bit hollow, for me it is not very pronounced enough to start the opening of a phrase, because as a starting phrase, you want to signal that you are there." (P1)

Furthermore, pianists drew links with vocal expression in the articulation of pitch height and melodic contour. P2 related to the hand position (high/low) 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 2). This may relate to everyday experience, as people use a lower position of the larynx to speak lower pitched words. P5 expressed her opinion about the timbre of a musical

phrase being like breath in speaking. Similarly, P2 suggested that the performance of a melody should be "natural, like speaking", drawing a parallel with prosody of spoken sentences.

> "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 seemingly metaphorical description of piano timbre become an embodied and cross-domain experience rather than simply a literal device (Zbikowski, 2008): abstract thoughts (e.g. richness; elephant-like) are mapped onto vocal actions (e.g. pronouncing, speaking in a low/large voice), which become hand-actions.

Theme 6: Corporeal Intentionality and Timbre Metaphors

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 descriptors/metaphors, at least from the perspective of the pianist. In particular, pianists addressed uses of physical and sonic tension-release, weight and motion.

Bodily tension/release as timbral tension/release. The corporal feeling of tension and relaxation in a performer's body might be transferred to verbal descriptions 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 vibrant. 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 proprioceptive 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 differentiate between more or less appropriate playing techniques. The explanations were however always closely coupled to the production of appropriate and intended sounds. The perception of timbre becomes a multimodal integration of auditory, visual, and proprioceptive sensations. From the performer's perspective, proprioceptive sensations have been claimed to be beneficial for pianists to improve and monitor their playing actions (Fieldon, 1934; Levinskaya, 1930); and the pianists' auditory experience is reinforced by the integration of proprioceptive feelings, enabling them to distinguish such subtle timbral differences.

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 the 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).

Tobias Mattay (1908) mentioned to convey weight upon the key and suggested that pianists would experience weight and energy transferring vertically by considering the direction, flow, and rotation of movements. In this sense, bodily movements are co-articulated to convey weight either vertically (shoulder-elbow-wrist-finger) or horizontally (finger-wrist rotation-neighboring finger). Pianists in our study demonstrated the importance of shaping co-articulation in timbre production: feelings of weight and tension were linked to techniques to balance timbre and bring out a melodic line in a chord progression or a polyphonic context. 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 color, and then melody notes come out." In addition, the rotation and transfer of weight makes the music "flowing" as compared to a straight and fixed hand (P4), because different parts of the body can move and coordinate fluidly.

The concept of weight is seen as crucial in piano performance and is closely related to details of pianistic technique. Berman (2000) mentioned the distinction between gestures that go 'in' (pouring weight) or 'out' (pulling fingers), when applying weight in piano performance. 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.

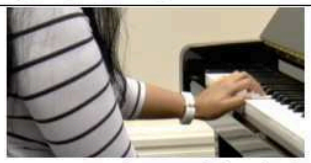
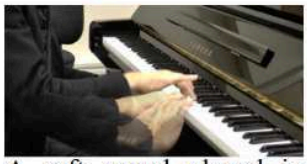
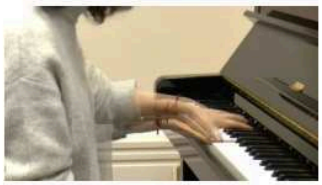
Moving gestures make moving sounds. Pianists related different qualities of touch to timbral intentions and outcomes, and they often referred to techniques by indicating movement

direction, such as "pushing" and "sliding" (P6), "moving forward" and "spreading" (P8), and "falling through" (P4). These impressions of gestures and touch qualities were mentioned to affect timbre, resulting in the perception of "moving" sounds. Pianist 3 suggested that the gesture of "falling through" the key made the sound travel (gestures are shown in Table 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]

Gesture examples and sound analysis. To illustrate these points further, Table 2 includes examples of the movements and hand positions that pianists made in their explanations of the production of certain timbres.

Table 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 a 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.

Intermediate Discussion

The latter three themes illustrate detailed examples of ways in which sound-producing and -facilitating gestures are linked to interpretative intentions and pianists' subjective experiences of piano timbre. When timbre production is described as speaking or singing, the sound-

producing gestures (fingers/hands/wrists) become the embodiments of simulated speech-related actions. When further examining timbre descriptors (e.g. heavy, hollow, ringing etc.), we found that sound-facilitating gestures (arms, elbows, upper body, positioning) and co-articulated bodily movements contribute to the global kinesthetic and motoric experiences of piano performance, making timbre felt with motions, weights, and tensions. Metaphors and adjective descriptors of piano timbre were found to be extensively utilized in the interviews, which has been investigated via linguistic approaches (e.g. Bellemere & Traube, 2005). However, this study provided rich insights in terms of its links with corporeal intentionality, implying that concepts and intentions are embodied and rooted in physical experiences (Lakoff & Johnson, 1980; Zbikowski, 2002).

Production of sound color and timbre was explained to demand a concentrated effort to create and fine-tune the intended sound. A high level of auditory sensitivity was explained to be required. Such fine-tuning is only possible through careful control of the piano, and we argue that the concentrated effort to moderate sounds is to moderate sounds as coupled to and goals of action. The concentrated effort is required 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 inherent restrictions of piano timbre. Nevertheless, the analogy is seen as highly useful for timbre production. This analogue is 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, Leman, Palmer, & Wanderley, 2013). Based on the reported results, we argue that this notion needs to be extended to include explicit influencing of perception through bodily action. Specifically, timbre perception is shaped by bodily exploration and interaction with sound, in a relatively dynamic and individual process.

Conclusion

This study investigated the understanding, production, and employment of piano timbre from the perspective of the performer with a particular focus on the role of gestures and bodily experiences associated with tone production. The main contributions of the study can be summarized as follows. Firstly, it offers a new perspective on timbre as holistic and embodied, which sheds light on the debate of touch-tone relationships in the context of piano performance. The pianists interpreted timbre in a holistic manner, being the sum of the various elements of performance, including compositional structure and performance characteristics. Through an interplay between composition and performance, timbre was seen to be composer and genre specific as well as unique to individual pianists. In line with embodied cognition theory, timbre is not solely a physical attribute of piano sound and touch-tone relationship is no longer a debate about 'yes or no' (in terms of whether touch affects piano timbre); instead, piano timbre is an embodied concept that is rooted in bodily experiences and shaped by auditory (i.e. heard tone

combinations), visual (i.e. hand/finger positions), haptic (i.e. force, soft, hard), and kinesthetic (tension, weight, motion) experiences.

Secondly, the study revealed the rich modalities and experiences that were relied on to inform choices and production of piano timbre. Relationships were made with orchestral instruments and sounds, gestures, and kinesthetic as well as visual imagery. Some of these were very indirectly related to timbre performance and included imagery of everyday and real-life scenes. Many others had quite close connections with sound production and performance. Movement was a prominent feature of many of the examples. Specifically, when talking about the production of particular timbres within a musical context, pianists conceptualized the hand as an articulator, parallel to the voice. Furthermore, frequent references were made to relationships between corporeal experiences and intended and expected sound effects. Experiences of weight, tension, relaxation, gravity and motion were related not only to sound-producing and -facilitating gestures, but also to subjective descriptions of the resulting piano sounds. This shows bodily enactment of timbre intentions as well as close association of the perceived timbre outcome with bodily production.

Thirdly, the interviews with the pianists in our study emphasized the benefits and values of the intrinsic sound-motion coupling for performers. Deliberate practice and motoric 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). In the interviews, pianists were also asked to explain the relevance of timbre for piano performance and how piano timbre is taught and learnt in their experience. For brevity and focus, responses to these questions were left out from the analysis and are reported elsewhere (Li, forthcoming). Nevertheless, the results show that timbre was seen as a central and important aspect of performance, and also something that requires consistent study over time.

Finally, this study explored the performer-instrument interaction which plays a crucial role in the conceptualization of piano timbre. In this context, the instrument and its keys and hammers seem to become an extension of the performer's physical gestures which, in turn, produce the desired piano tones. As also argued by several scholars (O'Modhrain & Gillespie, 2018; Nijs, 2017), the piano can be regarded as an extension of the performing body. Physically speaking, the piano timbre is affected by the control of the hammer movement, speed, and attacking 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) are inseparable parts of the experienced tone quality. 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 (O'Modhrain & Gillespie, 2018). Nijs (2017) related the merging of musicians and their instruments to 'flow experiences' 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). This experience has benefits for pianists, as Doğantan-Dack (2011) explained with respect to tone duration and preparation in piano performance. For example, while the piano is a percussive instrument, pianists develop specific performance gestures (i.e. falling through, dropping, releasing) to make the sound ring and sustain 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. This is not unlike the demonstration of the influence of performance movement on the perceived duration of marimba sounds (Schutz & Lipscomb, 2007). We argue that sound and body are blended in an embodied timbre concept.

Considering the perceived importance of timbre and its ubiquity in the experience of piano performance, its marginalization in the context of empirical performance research – which has often considered timing, or approached timing, dynamics, and articulation as separate entities, is striking. Furthermore, the focus on the sounds of single notes in the study of timbre seems to ignore essential aspects of how pianists view expressive timbre intensions as holistic and related to brief or longer phrases.

Although the interviews were held with only eight pianists, which is a clear limitation of this study, our results show the richness of pianists' ideas of and approach to timbre. All themes from the literature presented in the introduction were alluded to in the interviews and were further clarified. For example, timbre as a sound property is seen as the main objective. However, this is obtained through careful fine-tuning of movements and action preparation. In this process of coordination, a blended concept of timbre arises. This holistic and inclusive approach to timbre does 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. The present study showed the agreement between pianists and with previous literature. However, these findings need to be verified in further research. For example, verification of the holistic understanding comes from the modeling of the interplay between performance characteristics in the creation of an intended timbre, as Traube and her colleagues have started to do (Traube, 2017). Furthermore, experiments may test the effect of visual body

movement and gestures on the perception of timbre, as we have recently conducted (Li & Timmers, 2018).

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