Introduction

The primary objective of this research is to understand the relationship existing between a pianist’s touch and the tone quality resulting from it. The nature of this *tone-touch* relationship has been a point of debate amongst pianists for almost three hundred years. There is little agreement as to how the relationship operates, what is the precise nature of its cause and effect, or how it can be manipulated to optimise sound production.

Central to the debate is the disagreement amongst pianists about what constitutes optimal tone quality and whether there is a specific way of producing it. Generally, the views of musicians have been at odds with those of scientists. Pianists tend to attach subjective qualities to the tones, which they believe are a direct result of the specific touch form used. On the other hand, scientists have maintained that if a hammer hits a string at a given speed, its resultant sound spectrum is a direct consequence of the momentum transfer of the hammer onto the string, not the specifics of the touch, and is therefore independent of any subjective qualification. I have never been fully convinced by either argument and have always wondered whether a pianist can effect changes in the quality of the note independent of its volume.

Historically, neither pianists nor scientists have agreed on an answer despite the fervour and surety with which they tend to outline their reasons. As a preliminary example of the polar-opposite views encountered in the literature, compare nineteenth-century pianist Thalberg’s description of the tone-touch event with that of the twentieth-century scientist, Seashore. Thalberg (as cited in Kullak, 1972, p. 90) states that ‘For simple, tender, and graceful melodies one should knead the keys, so to speak, pressing and working them as with a boneless hand and fingers of velvet’ whereas Seashore (1937) writes,

> it makes no difference whether the key is struck by an accelerating, retarding, even, or any form of irregular movement, the only significant thing the player controls in the stroke is the velocity of the key at the exact moment that it throws off the hammer. (p. 361)

The problem for teachers and performers

From a personal perspective I have always found the question vital to my performance practice for a number of reasons. As a professional pianist, there is a constant desire – and expectation – to perform at a high level of technical and artistic excellence. Intimately bound to the success of this task is the ability to produce, and convey, a quality sound that may be varied and controlled as appropriate to any given musical context. Can one, as many claim, extend their tonal palette by any special form of touch? How, if at all, can it be achieved, and to whom should one turn for authoritative advice given the discrepancy of opinion amongst experts themselves?

Typically, a student may turn to their teacher or to piano pedagogical texts for help. Such sources may offer some occasional support though they may not provide definitive solutions. This is because, as this review will demonstrate, opinions on how to best do this, and what the underlying causal mechanism is, are diverse. Amongst experts, matters of dispute include the definition of tone quality, the ideal biomechanical posture, the manner of contacting the key and the relative contributions of finger and arm weight to key contact. The focus of this *exegesis,* therefore, is to review the strengths and weaknesses of each argument with a view to informing my professional performing practice.

Relevance and applicability to performance practice

If there is a proven way of varying tone quality, it should be known and incorporated into modern pedagogical theory and practice. If there is no known or proven way of varying tone quality, then pianists should be free to employ any physical movement that serves their musical goal. Naturally, many factors contribute to the piano tone which are beyond the pianist's control, including the fact that all pianos sound and feel different (even when they are of the same make and model), sound quality varies depending on the acoustic setting, and one's own perception of sound quality is influenced by proprioceptive and visual feedback. These elements add to the complexity of localising tone quality causality and will be addressed in this research too.

Understanding the tone-touch relationship may confer many benefits. Firstly, it allows the pianist to go straight to the point of finding the right sound, using the most appropriate means, and with the confidence that the physical approach is evidence-based. Secondly, it allows scientists to advise on how to optimise the biomechanics of touch without the fear that their advice is imposing upon any sacred, artistically-derived sound or protected pedagogical tradition. Sometimes authors give such focus to the nature of the body movement and its optimisation, that they lose sight of one of the primary duties of piano playing which is to produce the right sound.[1] This seems both counterintuitive and counterproductive, for to optimise a movement and not the sound itself has little practical application. Thirdly, understanding the tone-touch relationship allows one to transcend the dogma of pedagogical traditions – traditions that may serve to confuse the pianist, or worse, box them into a way of playing that is contrary to their natural anatomical or artistic disposition. In this case, a working knowledge of the tone-touch relationship would allow each pianist to choose a biomechanical pathway of least resistance rather than simply submit to one. Fourthly, it allows pianists and teachers to invest more time in the music making process and, specifically, the exploration of sound possibilities without the angst of wondering whether or not the sounds, or the means of producing them, would be pedagogically endorsed.

Methodology

This research takes the form of a literature review and critical discussion of the performance-based questions that underlie it. The tone-touch literature will be considered under two distinct categories: those that are derived from performance practice (Chapter 1 – Performance-based Perspectives) and those that are derived from scientific enquiry (Chapter 2 – Scientific Perspectives). A third chapter relates the findings back to a performance-practice context.

[1] See Chapter 1, Part 5, Pedagogical Theories and their Problems, especially the citations by

A great variety of opinions are presented in Chapter 1 (Performance-based Perspectives) and different ways of classifying them are demonstrated. Consideration for the instrument's evolution and its subsequently changing piano pedagogy is given (Parts 1-3). The multitude of opinions are then categorised under headings that reflect each author's underlying presumption as to the cause of tone quality (Part 4). Five sub-topics are considered here: definitions, postures, touch characteristics, instrumental factors and psychological factors. Choosing examples to illustrate these categories was a difficult task due to the wealth of material in the literature and because of the need to avoid the overrepresentation of any single opinion at the expense of failing to acknowledge alternative points of view. Common, notable, or unusual opinions guided such choices wherever possible. YouTube videos are also frequently referred to throughout the exegesis to validate certain points of discussion. A discussion on pedagogical theories and their problems (Part 5) concludes the chapter.

In Chapter 2 (Scientific Perspectives), the scientific literature is discussed. Scientific findings are presented under headings that reflect (possible) tone quality causality. These include hammer velocity, hammer-string interactions, hammer vibrations, extraneous sounds and sound perception. No opinions *per se* are featured in Chapter 2 except those that reflect the conclusions of the authors quoted.

In Chapter 3 (Conclusions and Applications), the literature review findings are summarised and examples of how they may be applied to a practical context will be offered. Reference is made here to the author's own repertoire and how the findings of this research have affected the process of learning and performance. This demonstrates a dynamic interplay between practice and research.

At this juncture, I wish to acknowledge the importance of the contributions of three authors in particular: Gerig, *Famous Pianists and Their Techniques* (1974); Ortmann, *The Physiological Mechanics of Piano Technique* (1962); and Askenfelt's papers from the 1990s (1990a, 1990b, 1991, 1993) on hammer motion, string vibrations and touch. These works are seminal works and provide detailed accounts of, respectively, the historical, biomechanical and physical explanations of the tone-touch relationship. Their works are frequently cited in this exegesis, as they are by other authors in their work. Parncutt and Troup, for example, cite all three authors in their chapter in Parncutt and McPherson's book, *The Science and Psychology of Music Performance* (2002).

This paper deliberately limits its focus to the examination of one singular aspect of piano technique: tone production. Understanding this has implications for technique, biomechanical optimisation, injury prevention, performing practices, interpretation and the subjective experience of sound perception. These claims will be justified later. I also acknowledge that a study of the physical properties of a single, isolated piano tone, stripped from its intended musico-acoustic context, is an artificial event rarely encountered in a normal performing scenario. In this respect, no judgements are made (or intended) about the musicianship or artistry of the pianists or teachers being evaluated, as the skills of a performing artist are complicated and varied (Williamon, 2004) and the tasks of the pianist are more extensive than the execution of single notes on the piano. Notwithstanding this, the single, isolated piano tone is the unbiased starting point upon which more complex piano sonorities are built and the nucleus upon which many technical methods are derived. False presumptions made by authors in regards to the tone-touch relationship may raise doubts as to the applicability of the conclusions they later draw. This, as will be shown, accounts for the wide and conflicting variety of opinion in how to produce any given tone quality.

Repertoire

The following repertoire has been studied and performed during the course of this research.

Recital No. 1: (Winthrop Hall, Perth, Australia, 12th April, 2012)

> **Beethoven – Sonata, Op. 27, No. 2**
> **Ravel – *Oiseaux tristes* (from *Miroirs*)**
> **C. Roberts – *Sad Bird Blues* (2008)**
> **Liszt – *Mephisto Waltz No. 1***
> **Chopin – *Préludes*, Op. 28**

Recital No. 2: (Elder Hall, Adelaide, Australia, 30th July, 2014)

> **Rachmaninoff – 24 Preludes**

Prelude, Op. 3, No. 2 [1893]

C sharp minor – *Lento*

Ten Preludes, Op. 23 [1903]

No. 1 – F sharp minor - *Largo*

No. 2 – B flat major - *Maestoso*

No. 3 – D minor - *Tempo di minuetto*

No. 4 – D major - *Andante cantabile*

No. 5 – G minor - *Alla marcia*

No. 6 – E flat major - *Andante*

No. 7 – C minor - *Allegro*

No. 8 – A flat major - *Allegro vivace*

No. 9 – E flat minor - *Presto*

No. 10 – G flat major – *Largo*

Thirteen Preludes, Op. 32 [1910]

No. 1 – C major - *Allegro vivace*

No. 2 – B flat minor - *Allegretto*

No. 3 – E major - *Allegro vivace*

No. 4 – E minor - *Allegro con brio*

No. 5 – G major - *Moderato*

No. 6 – F minor - *Allegro Appassionato*

No. 7 – F major - *Moderato*

No. 8 – A minor - *Vivo*

No. 9 – A major - *Allegro moderato*

No. 10 – B minor - *Lento*

No. 11 – B major - *Allegretto*

No. 12 – G sharp minor - *Allegro*

No. 13 – D flat major - *Grave*

Each of these recitals was open to the public and video recorded. Programs of these recitals are included in the appendices and recordings are included as attachments to this exegesis. The works span the Classical, Romantic, Late-Romantic, Impressionist and Contemporary periods. As these periods reflect different styles, instrumental development, and also changes in the pedagogical understanding of the tone-touch relationship, they provided a platform upon which I could explore the tone-touch relationship. The way in which the research findings relate to my preparation and performance of this repertoire are discussed in detail in Chapter 3.

Lecture-demonstrations

Also, over the course of my candidature, several lecture-demonstrations were given on the topic of the application of science to performance, focusing on aspects of the tone-touch relationship and topics covered in this exegesis. These lecture-demonstrations provided occasion to present and receive feedback on the ideas being explored in my research and performance practice. These presentations took place in the following venues:

1. Faculty of Music, University of Melbourne (March 22, 2010)

Audience: undergraduate and postgraduate piano students and faculty staff.

2. Australian National Academy of Music, (March 25, 2010)

Audience: student pianists of the Academy and faculty staff.

3. Australian National Academy of Music (April 1, 2010)

Audience: student pianists of the Academy and faculty staff.

4. Faculty of Music, University of Melbourne (April 2, 2012)

Audience: undergraduate and postgraduate piano students and faculty staff.

5. The 6th West Australian Music Teachers Association Piano Pedagogy Convention, University of Western Australia, (April 13-15, 2012).

Audience: piano teachers, students and professional pianists.

6. University of Adelaide (July 28, 2014), Faculty of Music

Audience: undergraduate and postgraduate piano students and faculty staff.

Chapter 1 – Performance-based Perspectives

Traditions and me – A pianist’s dilemma

I have had the great fortune of having esteemed teachers during all my years of piano study. Over this time I have accumulated many ideas on how to position and move my body, my hands and my fingers in order to produce different tone qualities. Sometimes I have been told to sit slightly high at the piano in order to allow the full weight of my arms to sink into the keybeds so that a deep, rich sound can be achieved. I have been cautioned to avoid stiffening in my shoulders but to allow some ‘give’ in my wrists to prevent my sound from ever becoming harsh or ugly. Certainly, I have been reminded to let the pads of my fingertips soak into the keys when trying to extract a singing tone from the instrument.

I have also been told on numerous occasions to sit slightly lower at the piano to let the weight of my arms sink into the keys, or, on occasions, to simply sit level with the keyboard to avoid any weight from my arms sinking into the keys. It is interesting that some teachers have told me to keep an imaginary straight line between my hand and my forearm and be vigilant that my wrists never ‘give’ lest I should lose tone quality. Once I was asked to try to avoid playing deep to the keybeds because this can interfere with the purity of the tone, or at loud volumes, produce a thumping sound. Somewhat controversially, it has been suggested to me that it does not matter whether I play on the tip, the flesh, or the side of my finger to make a singing tone because whatever I do it does not affect the sound quality.

Upon reflection, my scenario presents a dilemma, though it is probably not unique. How is it that so much expert advice can result in such diversity of opinion? Does tone quality actually exist or is it simply an illusion? My creative-practice journey starts with these questions and looks, initially, towards performance traditions to find an answer to the question: what element of piano technique is actually responsible for tone quality?

1. Introduction – The Importance of Tone: The Tone-Touch Relationship

Tone (sound) production is fundamental to the activity of music making. Amongst pianists seeking high artistic goals, a significant proportion of time is devoted to perfecting it, whether exploring the limits of one's tonal palette or learning how to control it. Some pianists consider the combination of the two the supreme goal of piano technique altogether. Pianist Vladimir Horowitz states, 'to be able to produce many varieties of sound, now that is what I call technique, and that is what I try to do' (as cited in Mach, 1991, p. 117). Chopin concurs, that 'The goal is not to learn to play everything with an equal sound, [but rather,] it seems to me, a well-formed technique that can control and vary a beautiful sound quality' (as cited in Eigeldinger, 1986, p. 31). Such remarks should come as no surprise, for to underestimate the value of sound production would, as pianist Boris Berman (2000, p. 3) points out, be 'as strange as ignoring color in visual arts, or body movement in acting'.

Understandably, given its all-pervading influence on piano technique, the pedagogical history is full of accounts of how to develop one's touch and how to develop one's tone. These accounts, however, when viewed as a whole, demonstrate a range of opinions that conflict in their explanation of how the tone-touch relationship operates. The object of this chapter is to present the diversity of these opinions and to examine the contexts in which they arise. To this end, both the traditional and a new way of classifying the literature will be presented.

2. The Development of the Piano: Early Pianos and Finger Technique

The following paragraphs give a brief account of how the piano has evolved since its initial construction in the early eighteenth century. The reader is asked to appreciate that there are significant differences (in sound quality and the mechanics of the action) between the early instruments and today's modern instruments. The evolution of tone-touch pedagogy is heavily influenced by the development of the instrument and a failure to acknowledge this risks misinterpreting the historical performance-based literature.

One potential area where the literature may be misinterpreted is when a modern performer directly applies what was said about tone and touch on the earlier instruments to a modern instrument without appreciating the differences. As Ferguson (1995, p. 9) explains, 'there is as great a difference of tone, and almost as great a difference of touch, between an early fortepiano and a modern pianoforte as there is between a fortepiano and either a harpsichord or a clavichord'. Naturally, as the piano evolved, each new instrument had its own distinct sound and mechanical feel which in turn dictated a different approach to playing them. This is largely self evident, as Kochevitsky (1967, p. 2) says, 'The technique of playing the older instruments and the new [twentieth century] one[s] had little in common'.

The earliest known pianos were invented by Bartolomeo Christofori at the beginning of the 1700s.[2] These instruments were described as a *gravicembalo col piano e forte* (harpsichord with soft and loud) and they were the first keyboard instruments (apart from the rarely used, and soon to become obsolete, clavichord) to allow the player to alter the volume of individual notes by way of touch (hence the name, *fortepiano*). This point remains contentious, however, with some harpsichordists maintaining that small variations in tonal quality can be effected by variations in touch. Whether or not this is true, it is enough that it was believed to be true, as it informs us of their assumptions about the tone-touch relationship. We note the observation of François Couperin (1716/1933, p. 12) that, 'It is reasonable to assume (apart from experience) that a hand falling from a height, gives a sharper blow than if it strikes from quite near, and that the quill will produce a harder tone from the string'.

The hand position adopted for playing these fortepianos was derived from the great harpsichordists, and involved having curved fingers with minimal movements of finger, arm and body. We note the biomechanical homogeneity of the following great Baroque harpsichordists:

[2] Various dates are disputed here, but the inventor's name is not: Christofori was inventing pianos from the earliest years of the 1700s and revising his inventions until his death in 1731 (Igrec, 2013, p. 1).

> F. Couperin – 'delicacy of touch depends also on holding the fingers as close to the keys as possible.' (Couperin, 1716/1933, p. 12)
>
> J.S. Bach – 'the five fingers are bent so that their points come into a straight line', and '[he played with] so small a motion of the fingers that it was hardly perceptible. Only the first joints of the fingers were in motion […] the fingers rose very little from the keys.' (Forkel, as cited in David & Mendel, 1996, pp. 308-309)
>
> F.G. Handel – '[his fingers] were so curved and compact that when he played no motion and scarcely the fingers themselves could be discovered.' (see Blom, 1954, p. 745)
>
> C.P.E. Bach (an early Classical fortepianist) – 'the fingers should be arched, and the muscles relaxed.' (C.P.E.Bach, 1753/1949, pp. 42-43)

Early fortepianos had a weak sound by modern standards, due in part to their 'mainly wooden frame, thin, comparatively low-tensioned strings, and small leather-covered hammers' (Ferguson, 1995, p. 10). Further improvements were made by Christofori and other instrument makers, though these early instruments were not widely used or endorsed (Fletcher & Rossing, 1998, p. 352). In 1736, J.S. Bach judged an instrument made by Silbermann to be 'too weak in the high register and too hard to play' (as cited in David & Mendel, 1996, p. 259). The instruments of Stein in 1773, however, represented a leap forward and had a 'light and reliable action, a well-matched treble and bass, and a pleasing though not particularly powerful singing tone' (Ferguson, 1995, p. 10). W.A. Mozart (1777, as cited in Anderson, 1966, pp. 328-329) praised these instruments for their evenness of tone when he stated, 'In whatever way I touch the keys, the tone is always even. It never jars, it is never stronger or weaker'. The light actions of Stein's fortepianos, and later those of Streicher's, reached their peak in popularity and technical perfection around the end of the eighteenth century, and became collectively known as the Viennese action. [3] Historically, it was an end-point in the development of the light-actioned pianos.

It is a notable omission of the literature of this period that specific discussion of the tone-touch relationship is almost entirely absent. Neither is there any suggestion that anything but a curved-finger technique (adopted from the Baroque instrumentalists) was the mode of touch being used. There are several possible reasons for this. Firstly, the size of the keys was much smaller, necessitating a curved-finger position. Secondly, the forces required to play the fortepiano were still so small that nothing beyond a close, light finger touch was ever required, (even if there were perceived nuances of sound quality within a set dynamic).

It is interesting to note that neither of the two most prominent fortepianists of the day, Mozart and Clementi, demonstrated or documented anything to suggest that a different technique was ever required or sought. Mozart, as previously quoted, admired the Stein instrument for being 'even' in tone quality despite variations of touch. This alludes to Mozart's desire for a certain tonal equality in playing. We may wonder here whether he was aspiring to the consistency of the harpsichord's tone and feel, or indirectly referring to the tone-touch inconsistencies of many of the early fortepianos. He did, however, caution his sister 'not to practise these passages [large stretches in a Clementi Sonata] too much, so that she may not spoil her quiet, even touch' (as cited in Anderson, 1966, p. 850). For Mozart, equality and evenness in touch were esteemed qualities, though in this instance it is not clear whether he was referring to temporal or dynamic equality. Clementi (1803, pp. 14-15) added nothing new to the eighteenth-century biomechanical *status quo* when he wrote that 'The fingers and thumb should be placed over the keys, always ready to strike, bending the fingers in, more or less in proportion to their length'.

Finally, if we reflect on J.S. Bach's and Mozart's remarks, it would seem that the instrument itself had the overriding influence on piano tone quality rather than any specific touch on the performer's part. Pianist Paul Badura-Skoda corroborates this

[3] For a brief summary see Ferguson, H. (1995). *Keyboard Interpretation from the 14th to the 19th Century*: Oxford University Press p. 10. For more detailed history, see Igrec, M. (2013). *Pianos Inside Out*. Mandeville: In Tune Press, Chapter 1.

assertion in his vivid description of the pre-determined sound qualities of these early instruments:

> The Mozart pianos of Stein and Walter, for instance, were clear and very bright in the upper register, and this made it easier to play cantabile and with full colour. The lower notes had a peculiar round fullness, but none of the dull, stodgy sound of the low notes of a modern piano […] The tone becomes steadily thinner toward the top. (P. Badura-Skoda & E. Badura-Skoda, 1962, p. 10)

Such observations do not infer that tone quality held no importance for the fortepianists, but point out the fact that at this point in the history of piano practice no specific correlations were being made between the performer's touch and the tonal result – all touch was finger touch, and instrumental design was probably the greatest determinant of the tone quality of individual notes.

The English company Broadwood (founded in 1773) produced instruments that were larger and more powerful in tone than the Viennese fortepianos. The strings were larger, strung at higher tension and the hammers, heavier (see Gerig, 1974, chap. 3; Igrec, 2013, chap. 1). The heavier action of these instruments was liked by some pianists and disliked by others who were accustomed to the lighter Stein action. For example, Ferguson (1995, p. 10) quotes Haydn, Clementi, Dussek and Beethoven as admirers of the new instrument, though Hummel apparently had his own reservations: 'this instrument does not admit of the same facility of execution as the German; the touch is much heavier, the key sinks much deeper' (as cited in Gerig, 1974, pp. 78-79).

Misconceptions surround the definition of touch heaviness. Piano maker Walter Pfeiffer (as cited in Igrec, 2013) points out that heaviness to touch is a complex phenomenon, partly subjective in nature and partly mechanical, of which the latter is only partially correlated to the actual weight of the key. He explains that the force required to overcome a key's weight in soft playing (static touchweight) is different to the force required when playing loudly (dynamic touchweight). He warns us that we should not use static touchweight as our reference on which to make judgements about the heaviness or playability of a piano's action. Pfeiffer writes, 'The static touchweight [of the early nineteenth century English pianos] was actually lower than in most Viennese instruments [though they felt heavier]' (cited in Igrec, p. 275). Moreover, a Broadwood piano from 1817 had static touchweights of 74 g (low bass), 67 g (middle register) and 50 g (high treble) (Blom, 1954, p. 748) – that is, were heavier than those of modern instruments, though they felt lighter to play than modern instruments.[4]

So how can this apparent paradox be explained? Two possible explanations give us a clue. The first, is that the dynamic touchweight, which accounts for the feel of the touch, is influenced by many underlying factors, including, not least, the hammer weight, action leverage, the amount of leads in keys and other springs (Igrec, 2013, p. 275). The second explanation is that the heavy feel of the English instrument is a consequence of the increased distance that a key has to be depressed before the hammer is released toward the string. This distance is called the key dip and it was found to be 4-6 mm in Viennese pianos and 7-7.5 mm in English pianos. (Note, today's instruments have a much larger key dip of 9.5-11 mm). 'Large key dip gives the action power, but requires extra effort by the player because the fingers have to move farther' (Igrec, p. 275). This could well explain Hummel's remark that the touch feels much heavier on the English instruments.

The Broadwood instrument met with Beethoven's approval when he received one as a gift in 1818. His endorsement of it, along with that of other (previously mentioned) major composer-pianists contributed to an important shift in piano pedagogy's unfolding understanding of the relationship of a performer's touch to tone quality. Beethoven's noted pupil Carl Czerny commented on Beethoven's novel way of treating the instrument, observing that 'He especially insisted on legato technique, which was one of the unforgettable features of his playing' (Czerny, 1842/1956, p. 307). Schindler (as cited in Gerig, 1974), Beethoven's friend and biographer, claimed that Beethoven advised students to:

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[4] Modern concert grand pianos are regulated to around 48 g, with a few grams less in the treble, and a few grams more in the bass (see Igrec, 2013, p. 276). Other sources concur with this, for example, see the Fazioli pianos website:
http://www.fazioli.com/en/fazioli/philosophy/weighing-the-keyboard

> place the hands over the keyboard in such a position that the fingers need not be raised more than is necessary. This is the only method by which the player can learn to *generate tone*, and, as it were, to make the instrument sing. (p. 91)

Schindler (1860/1966, p. 380) also remarked that, 'he [Beethoven] set great store by the manner of striking the keys, and its double import: the physical or material, and the psychological'.

No pianist prior to Beethoven had challenged the piano's tonal possibilities to such extremes. In one of his sketchbooks, Beethoven himself annotated a *legato* passage, instructing the pianist to have 'the hand contracted as much as possible' (as cited in Gerig, 1974, p. 93). Beethoven was using specific hand postures to generate specific sounds. He believed (whether consciously or unconsciously) in a direct relationship between the manner of treating the key and its effect on sound quality.

Hence, Beethoven's original approach marked a pivotal moment in the history of piano pedagogy. He implicated a new model of understanding the tone-touch relationship that presupposes the following assumptions. Firstly, that tone on the piano can indeed be generated, independently of the instrument's inbuilt characteristics; secondly, that the tonal quality can be altered (independently of intensity) by touch; and lastly, that the manner of striking the keys affects, or is affected by, a psychological component (for the performer and the listener). Of course we cannot presume that Beethoven was the only pianist to believe in this new tone-touch relationship. Certainly, other pianists were also experimenting with the new instruments and the new tone-touch feeling. It was, however, Beethoven's explicit detailing of how touch effects tone quality that sets him apart. Other contemporary pianists, including those especially noted and admired for their singing style, e.g. Dussek (1760-1812), Cramer (1771-1858) and Field (1782-1837), did not formally describe any new manner of playing as being different from what was typically in use during this period. As to be expected, following Beethoven, further exploration of the new tone-touch feeling led to new models of understanding tone quality causality. Such models lie at the core of the many piano methods that later flourished during the nineteenth century – the topic of the next section.

It is significant to note that further developments of the piano, though important, did not shift the focus of pedagogy away from the possibility of a touch-sensitive tone-touch relationship. The nineteenth-century instrument makers were generally concerned with 'meeting the demand for a larger and more powerful instrument, which would be suitable for use in concert halls and capable of fulfilling the requirements of virtuosi such as Liszt and Thalberg' (Ferguson, 1995, p. 11). To this end, the most important advance in piano design was the introduction of a cast iron frame (patented by Babcock in 1825). This allowed the addition of more keys and more strings to the piano, drawn at higher tensions, and the subsequent evolution of larger, heavier, felt-covered hammers. This, along with other mechanical advances (e.g. Erard's double-escape action, 1821) led to the birth of the so-called modern piano (produced by Broadwood and Steinway in the 1850s.) Further perfecting of the instrument by Steinway (forty-nine patents between 1860 and 1880) saw the instrument reach its modern form (Igrec, 2013, p. 14). Such changes allowed pianists to explore a wider range of tonal possibilities either through improvisation or written composition (consider, for example, the tonal variety demonstrated in Liszt´s piano transcriptions, including *Mephisto Waltz No. 1*, as performed by this author, which explore tonal extremes). The expanded range of tonal colours of the piano in turn gave way to new ideas of how to best produce them. Piano pedagogy was about to take many new directions.

In regards to tone-touch pedagogy, the important point to note here is not the many intricacies of the piano's development but rather the fact that the piano was still 'in development' up until the 1880s, whereupon its mechanism and tonal qualities had stabilised into its current form. Accordingly, prior to this date (and particularly prior to the 1850s) opinions stated regarding the tone-touch relationship should be considered in relation to the specific type of instrument being used. Conversely, from the 1880s onwards, differences in opinion of the tone-touch relationship were not the result of changes in instrument design, and should therefore not be based upon it.

3. Classifying the Tone-Touch literature (1): Traditional categories

Evidently, the piano evolved significantly over the two hundred years from 1700-1900. The same period also saw the evolution of many styles, including the Baroque, Classical, Romantic, Impressionism and early Modernism. On account of the interplay between these two evolving paths (instrumental design and performance practice) we can expect a diverse range of opinion on how the tone-touch relationship operates, and this is certainly the case. Standard classification, however, does not account for this variety. There is no dispute in the literature that a curved finger technique was the default technique of the Baroque era until the end of the Classical period (c.1650-1800). At this juncture, however, as we have seen, the instruments began to offer more sonority, which, in turn, came at the expense of requiring more force to overcome key resistance. The way in which pianists related the new piano's sonority to its feel accounts for the variety of opinion in the pedagogical debate that ensued.

Plainly, the extra key resistance had to be overcome. Two different biomechanical solutions subsequently evolved, both in theory and in practice: one, by striking faster or harder with the fingers, and the other, by transmitting a larger amount of arm weight (via the finger) to the key. By the end of the nineteenth century, these approaches had become associated with two opposing schools of technique, *Finger* and *Arm-weight*, respectively – see, for example Gerig (1974, chap. 12 & chap. 14) or Schonberg (1987, pp. 293-294). This binary classification system is routinely used in the literature. Closer evaluation, however, shows that it oversimplifies the models they describe, their historical development, and the biomechanical processes which they purport occurs. As with the history of the piano's development, it is necessary to understand the context in which these two schools of thought arose, for much misconception surrounds them and this impacts on how the tone-touch is evaluated.

A. Finger methods

Finger methods, or the finger 'school', through their never-ending prescription of finger exercises and studies has, for the greater part, been responsible for promoting finger speed and dexterity. One of the most notable features of this method is the striving for finger strength and touch equality with a relative neglect for other tone-touch subtleties. Virtuosi pianists Clementi and Hummel, whose careers started on fortepianos, did not appear to use anything but finger strength to overcome the key resistance of the new pianos. Finger exercises dominated their approach to piano pedagogy and though their music demands the execution of many different touch forms, there is no indication in their contributions to piano pedagogy that arm-weight techniques were ever deliberately used or cultivated. Clementi's 100 Etudes in *Gradus ad Parnassum,* (1826), and Hummel's *A Complete Theoretical and Practical Course of Instruction,* (1828, which includes over 2,200 exercises) are indicative of their predilection for finger technique.

Hanon, in his renowned *The Virtuoso Pianist* (first published in 1873), encapsulates the finger school philosophy when he states, 'if all five fingers of the hand were absolutely equally well trained, they would be ready to execute anything written for the instrument' (Hanon, 1900, Preface). At the commencement of the first exercise he indicates the goal of his exercises as being 'for the acquirement of Agility, Independence, Strength and Perfect Evenness in the Fingers' (p. 2).

The high-finger lift, and *forte* attack endorsed by the teachers of the Stuttgart School, represents a pedagogical extreme, both in its method and its popularity in its day. Its method, articulated by Lebert and Stark in *Grosse theoretisch-praktische Klavierschule* (Grand theoretical-practical school of piano playing, 1856) claims, 'by the term technique we mean the right formation of tone, that is, the ability to elicit from the instrument a beautiful, rich tone' (as cited in Gerig, 1974, p. 231). The claims, however, are not substantiated by Amy Fay, a student of the same school. Her personal reflection suggests that there was a discrepancy between what was being theorised and what was being taught. She writes, 'You have no idea how hard they make Cramer's Studies here. Ehlert makes me play them tremendously *forte*, and as fast as I can go. My hand gets so tired that it is ready to break' (Gerig, 1974, p. 236).

The assumption that all exponents of the finger school shared the same view, however, is untrue. Closer evaluation of two, often-despised, finger-school pedagogues Czerny and Kalkbrenner demonstrates this point. Czerny, famed for his *The School of Velocity,* Op. 299 (1830s), *Piano Forte School*, Op. 500 (1839) and *The Art of Finger Dexterity* Op. 740 (1844) was a gifted pianist (accepted by Beethoven as a student) and also a renowned teacher – the young Liszt learned from him. Despite his aptitude and fame for composing finger studies, this did not preclude his interest in the cultivation of subtle touch-tone nuances. Clearly he was an advocate of using arm weight – with discretion – when he wrote,

> the crescendo should never be produced by a visible exertion of the hands, or by lifting up the fingers higher than usual, when we are playing legato; but only by an increased internal action of the nerves, and by a greater degree of weight. (Czerny, 1839, as cited in Gerig, 1974, p. 112)

Part III of his *Piano Forte School* encourages the exploration of the relationship of touch to sound variety. The following passage is evidence that he believed that small variations in touch pressure could affect tone quality, independent of the tonal intensity: 'We must observe that by this change from a heavier to a lighter pressure, very different qualities of tone may be produced from the Pianoforte; even when we play the whole with an equal degree of piano' (Czerny, 1839, p. 41). Czerny certainly aspired to tonal beauty and clearly believed that it was something that could be taught. He recalls this proudly in reference to his mentoring of the young Liszt when he writes, 'I taught him beautiful touch and tone' (Czerny, 1842/1956, p. 314).

Similarly, Kalkbrenner, who was considered the finest pianist in Paris at the time of Chopin's arrival in the 1830s (see Eigeldinger, 1986, p. 95) appeared to endorse the Finger school principles. This is evidenced by his finger training *Méthode* (1830) and his invention of the *guide-mains* which was specifically designed to 'isolate' the fingers from the arm and prevent any arm weight from interfering with finger movement when playing.[5] There seems to be little consistency to his theory, however, as he goes on to describe sophisticated touch forms in his *Méthode* that require various degrees of arm-weight involvement. He writes, 'one must now caress the key, now pounce upon it […], while drawing from the instrument all the tone

[5] This was a mechanical device - adapted from Logier's *Chiroplast* – which was a railing attached to the piano upon which rests the forearm whilst practicing.

possible, avoid striking it' (Kalkbrenner, as cited in Gerig, 1974, p. 132). The use of the word 'drawing' implies that he believed in some special way of touching the key that could generate a certain sound quality. The distinction between a generated sound (actively determined) and a merely resultant sound (passively determined) is, from a tone-touch pedagogy point of view, extremely important.

In contrast to the Stuttgart finger-school, Kalkbrenner never advocated a high finger lift, but rather a more considered and sensitive relationship of the finger on the key. He continues that: 'The manner of striking the key must exhibit innumerable variations, corresponding to the various emotions to be expressed' (as cited in Gerig, 1974, p. 132). With obvious concern for the subtle relationship of touch-tone, he also writes, 'hold them [the fingers] closer to the keys, especially in legato passages, to make them more finished and obtain altogether a rounder and more ringing tone' (p. 131). This remark resonates with that of Beethoven, as mentioned previously, and also with that of his teacher, Louis Adam, who suggested that 'Only through the touch can a fine tone be obtained' (Adam, 1798, as cited in Gerig, p. 130).

Both Czerny and Kalkbrenner were searching for tonal nuances that demanded much more involvement of the arm than their finger exercises would suggest. They exemplify the fact that there are discrepancies between what is written and what is practised. A superficial appraisal of finger touch pedagogy would not expose this. The comments of Adam, Beethoven, Czerny and Kalkbrenner all implicate a belief that tone quality exists independent of its tonal intensity – a view quite different from the mechanistic view of finger technique. Certainly, the Finger school promoted finger dexterity at the expense of arm weight, but there is no reason to believe that in the hands of the greatest pianists it actually occurred, or came at the expense of the pursuit of specific tone qualities. It was the variety and description of the means of producing tone that were still in their infancy.

B. Arm-weight methods

An alternative approach to overcoming the increasing key resistance of the nineteenth-century instruments was to allow various degrees of arm weight to be transmitted through the finger into the key at the moment of impact. Theories built on this principle are considered under the category of *Arm-weight* methods. To its authors, the manner in which the arm weight is dropped onto the key is of great importance, for weight carries not only a biomechanical function (to overcome key resistance) but is considered to influence sound quality as well. As Palmieri (2003, p. 386) writes, 'in the last quarter of the nineteenth century, the use of arm weight and muscle relaxation became a widespread and primary concern'. The description, application and function of the Arm-weight methods evolved significantly during the nineteenth century, and although they are often grouped in the literature under a single, generalisable category, the definition of Arm-weight playing has never been universally agreed upon.

From a pedagogic point of view, the name synonymous with the archetypal Arm-weight method is Rudolf Breithaupt. His publications, highly theoretical and systematic in their categorisation of movements, took the nineteenth-century ideas on weight playing to a pedagogical end-point (see, for example, his tomes *Die natürliche Klaviertechnik vol.1* (1905), *vol.2* (1909), and *Praktische Übungen* (1916-1921). His main tenets of weight playing were that the arm remains as relaxed as possible, that its weight is transferred through the fingers which act as supports for the weight, taking little, if any active role in key depression, and that this type of touch produces the ideal singing tone. Gerig (1974) cites Breithaupt:

> Every movement must be supple, perfectly free from muscular contraction or stiffness, every joint, muscle and sinew of the limb being relaxed (p. 343); The fingers must not be raised, they merely take turns in carrying and transmitting the weight (p. 343); [This produces a] full, sonorous and round [sound]. (p. 354)

Within the category of Arm-weight methods, the role of the arm weight is often divided between serving a biomechanical function and a quality-tone-producing function. Sometimes the division is not clear and this creates ambiguity in interpreting their pedagogical claims. For example, two generations prior to Breithaupt's major publications, Kullak (1860/1972, p. 150) wrote, 'the weight of the arm aides [sic] the pressure of the fingers and augments the singing tone'. And

Deppe, a forerunner of Breithaupt, stated, 'tone production does not develop through striking, but solely through the weight of the hand […] with quiet, relaxed fingers' (1855, as cited in Gerig, 1974, p. 253).

Sometimes, the utility of arm-weight playing is shifted away from biomechanics altogether – at least in theory. The idea that arm weight is the very cause of the singing tone, rather than simply an aid to its production is maintained by Lhevinne. He asserts, 'a touch without weight has no tone quality' (Lhevinne, 1923, p. 7), suggesting that the movement of the finger is somehow obsolete in producing a singing tone.

The fusion of the concept of arm weight with tone quality, be it real or theoretical, is a common feature of Arm-weight methods. It cultivates the idea that different amounts of weight may influence tone quality to different degrees. As a consequence of this way of thinking, the control of arm weight becomes of paramount importance. The unification of the body with the instrument, (that is, the arm with the key), becomes not only a biomechanical goal but also an artistic goal. Safonoff, teacher of Rachmaninoff, Scriabin and Lhevinne, emphasises the feel of the movement when he writes, 'the sound must never be produced by hitting the keys, but by an elastic fall on them from the root of the fingers, so that the weight of the arm is felt in the finger-tips' (Safonoff, 1915, p. 15). Such a view demonstrates an intentional unification of the concepts of arm weight with finger pressure and sound quality. Famed Russian teacher Igumnov takes this a step further when he suggests that 'muscular sensations when playing the piano are something that has to be felt [and that] one should somehow become at one with the keyboard' (as cited in Barnes, 2008, p. 78).

Both Safonoff's and Igumnov's comments allude to a multisensory synthesis of the touch elements that tries to transcend a purely mechanistic model of tone production. This way of thinking is widely represented in the literature and it hints at a metaphysical model of understanding the tone-touch relationship often found in the twentieth century (see Chapter 1, Part 4, Section E. Psychology – The Perception of Sound Quality).

4. Classifying the Tone-Touch literature (2): New Categories

To discuss the tone-touch relationship using only a *Finger* or *Arm-weight* model grossly underestimates the complexity of the tone-touch classification: there is too much heterogeneity of definition within each category, and there is too much hybridisation of one model with the other for either of them to be fairly discussed in this way. The number of uncontrolled mechanical variables also makes it difficult (and dangerous) to make generalisations about cause and effect, as Chapter 2 demonstrates. A possible, alternative way of classifying the literature may be based on the specific assumptions that authors make when discussing tone quality causality. Such assumptions do not limit themselves to any single pedagogical theory. On the contrary, they are bound to all periods and styles. Thus, in an attempt to understand the question, 'where does the cause of tone quality lie?' the following categories will be used:

A. Definitions – The problem of defining tone quality
B. Postures – Positions and Anatomy
C. Touch – The Nature of the Key Contact
D. Instrument – Pianos, Acoustics, Technicians
E. Psychology – The Perception of Sound Quality

A. Definitions – The problem of defining tone quality

The idea that a single piano tone carries a subjective quality (e.g. 'rich', 'round', 'full' etc.) is a contentious subject. Some pianists believe that, independent of any musical context, the quality of a tone may be manipulated, or generated, by some specialised means of touch. This gives rise to the idea that a piano tone may not only be defined by the subjective quality (e.g. 'rich') but judged further by whether or not it actually achieves the desired quality, that is, 'good' or 'bad'. Sometimes it is a challenge for the reader to differentiate between an author's use of the term 'good': whether it is being used in an absolute (descriptive) sense or simply to mean good 'relative to the desired tonal goal'.

The distinction is important, however, because those who tend towards absolute definitions of tonal qualities invariably tend also towards prescribed, biomechanical approaches to producing them. Curiously, one of the most frequent points of reference in which authors choose to define tone quality is that of whether or not the tone has a 'singing' quality. The implications for pianists and piano pedagogy in assuming that such an absolute quality exists are explored in this section.

Twentieth-century virtuoso pianist and renowned teacher Josef Lhevinne is representative of the group which define the piano tone with a subjective quality. For example, in his book Basic Principles in Pianoforte Playing (1924/1972) he devotes an entire chapter to 'The Secret of a Beautiful Tone' (p. 17) and a further subsection on 'The ringing, singing tone'. He makes an unmistakable link between 'beautiful' and 'ringing, singing'. Furthermore, Lhevinne is resolute in his belief that a pianist must invest technical effort in acquiring tone quality. He writes, 'by hard work and experience in listening to pianists who do possess a beautiful tone, you may develop it' (p. 17) and 'if the student has the privilege of studying it under a good teacher, it may be more rapidly acquired' (p. 16). Lhevinne makes several assumptions: firstly, that a singing tone exists; secondly, that a singing tone can be cultivated; and thirdly, that a singing tone is beautiful.

The idea that tone qualities can be defined and acquired is further endorsed by one of the twentieth-centuries most famous pedagogues, Heinrich Neuhaus. He writes, 'the first and main concern of every pianist should be to acquire a deep, full, rich tone capable of any nuance' (Neuhaus, 1958/1993, p. 67). He later qualifies his statement, however, to mean that tone quality is a relative phenomenon; he writes that ''a beautiful tone' is a most complex process combining and ordering the relationship of tones of varying strength, varying duration, etc., etc., into a single entity' (p. 68).

As mentioned, there is a predilection amongst pianists and teachers to devote time to acquiring a singing tone. To be expected, a singing tone is one that has the same attributes as those of a great singer. The following sample of descriptive terms reflects the subjective nature of this tonal goal to which some pianists strive: 'deep, full, rich',[6] 'lovely, ringing, singing',[7] 'full, sonorous and round',[8] 'rounder and ringing',[9] 'sympathetic (and carrying)',[10] 'sustaining'.[11] The list is not exhaustive.

Undesirable tone or 'bad' tone, should the term be used, is frequently defined by features that are the antithesis of the singing ideal, that is, sounds of a percussive nature. Within this context, representative examples from the literature include the following: 'hard, metallic tone',[12] 'a 'thud' […] harsh',[13] 'forced, strangulated tone',[14] 'percussive',[15] 'dryness'.[16] Explanations for how such a tone is produced is relatively consistent in the literature: 'produced by hitting the keys',[17] 'by roughly striking the keys',[18] 'when the Key is jerked down by a too suddenly applied impulse',[19] 'if it is hard in quality then you are forcing, or thrusting'.[20] The derogation in status of 'sound' to 'noise' is also noted by Neuhaus (1958/1993, p. 58) who writes, 'if I let my hand fall on the key too fast and with too much force […] I get a noise; it is no longer a tone.' Australian virtuoso pianist and pedagogue Mack Jost (1974, p. 12) concurs, 'Key struck and key-bed struck = noise'.

Not everybody believes in the idea of defining tone quality with subjective terms. Typically, it has been the scientists who have been castigated for refusing to give in

[6] Neuhaus, H. (1993). *The Art of Piano Playing* (K. A. Leibovitch, Trans.). London: Kahn and Avarill p. 67

[7] Lhevinne, J. (1972). *Basic Principles in Pianoforte Playing*. New York: Dover Publications p. 18

[8] Translation from Breithaupt, R., *Natural Piano-Technique* II, 1909, cited in Gerig, R. (1974). *Famous Pianists and their Technique*. Washington: R.B.Luce p. 354

[9] Kalkbrenner's words, taken from Halle, C. (1896). *Life and Letters of Sir Charles Hallé*. London: Smith, Elder and Co. cited in Gerig, R. (1974). *Famous Pianists and their Technique*. Washington: R.B.Luce p. 131

[10] Matthay, T. (1903). *The Act of Touch in All its Diversity*. London: Bosworth and Co p. 89

[11] Goldenweiser's words, cited in Barnes, C. (2008). *The Russian Piano School*. London: Kahn and Averill p. 56

[12] Lhevinne, J. (1972). *Basic Principles in Pianoforte Playing*. New York: Dover Publications p. 18

[13] Fielden, T. (1961). *The Science of Pianoforte Technique*. London: Macmillan & Co Ltd p. 53

[14] Berman, B. (2000). *Notes from the Pianist's Bench*. New Haven & London: Yale University Press p. 12

[15] John Browning's words, cited in Mach, E. (1991). *Great Contemporary Pianists Speak for Themselves*. New York: Dover Publications p. 39

[16] Liszt's words, quoted by Mme. Auguste Boissier, cited in Gerig, R. (1974). *Famous Pianists and their Technique*. Washington: R.B.Luce p. 181

[17] Safonoff, W. (1915). *New Formula for the Piano Teacher and Piano Student* (English edition ed.). London: J & W Chester p. 15

[18] Thalberg's words, cited in Gerig, R. (1974). *Famous Pianists and their Technique*. Washington: R.B.Luce p. 174

[19] Matthay, T. (1960). *The Visible and Invisible in Pianoforte Technique*. London: Oxford University Press p. 7

[20] Jost, M. (1974). *Yet Another Guide to Piano Playing* (3rd ed.). Melbourne, Australia: Allans Publishing p. 23

to using subjective descriptions to define tone quality, but this is not necessarily fair. Many pianists also hold the opinion that the piano sound has no innate, subjective quality whatsoever. Pianist-composer Percy Grainger demonstrates this view of sound quality when he states: ‘what in the orchestra, for instance, is accomplished largely by contrasts of *quality* we on the piano must accomplish by contrasts of *quantity*, or different sound strengths’ (as cited in Cooke, 1999, p. 369).

Other pianists use other words to state the same. Samuil Feinberg, for example, asserts, ‘we cannot distinguish whether the key is pressed down by a finger, by a wad of cotton wool, or – with the same intensity – by a piece of metal’ (as cited in Barnes, 2008, p. 4). Abby Whiteside (1969, p. 153) overtly disagrees with the idea of defining the piano tone altogether, stating that ‘one cannot ‘color’ a piano tone […] There is no such thing as a ‘singing’ tone with the piano […] There is no ‘harsh’ tone’.

The act of defining tone quality is an important matter. Many authors expound their entire methods based on their personal definition of tone quality and an ideological protection of it. Methods advise on the biomechanics of playing, which in turn can affect the ease, or difficulty, of playing. I contend that any method imposing upon the natural freedom of a performer for the sake of maintaining an unproven entity (sound quality) should be questioned. The following sections explore some of the potential effects of defining tone in absolute terms, and the assumptions that underlie it.

B. Postures – Positions and Anatomy

For those pianists who believe in the existence of specific, individual tone quality, a correlation is often made between the tone quality of the note and the position of the pianist’s finger at the point of impact. Excluding piano pedagogy up to c.1800, when all piano technique involved curved fingers (see Chapter 1, Part 2), many diverse finger positions have since been adopted in the belief that they correlate to different sound qualities. Three factors commonly implicated are finger position, finger size, and piano seat height.

i. Flat fingers

In regards to producing a singing tone, it is common practice in modern pianism to allow the fingers to uncurl slightly in order to allow the fleshy part of the finger to contact the key. Leschetizky actively encouraged such practice at the end of the nineteenth century, stating that 'the elastic finger-tip gives a richer tone than the hard nail' (as cited in Brée, 1913/1997, p. 5). And Josef Lhevinne (1924/1972, p. 14), was convinced that 'the thicker the cushions of flesh upon the fingertips, the wider the range of variety of touch'. Virtuoso pianist Horowitz concurs: 'You get a better sound that way […] the entire ball of the finger, not merely the tip, is on the key' (as cited in Schonberg, 1992, p. 296) – though we will later see that his playing did not always comply with his word. In the twenty-first century, pianist Boris Berman (2000, p. 12) writes, 'a singing sound of great warmth will succeed if the fingers assume a flatter position'.

The approach is by no means universally accepted, however, and the diversity of finger positions endorsed by other experts would suggest that the association of any particular finger position to sound quality might be fictitious. On the early modern instruments, pianist John Field was praised for his singing touch, despite the fact that 'he played the piano with fingers standing almost perpendicular to the keyboard. His beautiful tone was explained, quite seriously, by this hand position' (according to a student of Field's, cited in Kochevitsky, 1967, p. 38).

Hummel, who played on the same types of instruments as Field, opposed the flat finger position altogether, saying that 'extending the fingers flat on the keys and as it were, boring into them by letting the hands hang downwards are altogether faulty positions' (1827, as cited in Gerig, 1974, p. 73). Beethoven's annotation of a *legato* passage, advising the pianist to have 'the hand contracted as much as possible',[21] suggests that he used a profoundly curved finger position to achieve a singing tone

[21] This annotation is found in an unpublished copy of original exercises for the piano by Beethoven, cited in Gerig, 1974, p. 93.

quality. We cannot, therefore, ignore the fact that round fingers are frequently implicated in producing a singing tone. Brendel (1976, p. 95) gives a description of how he produces the oboe's singing tone when he writes, '[play it] with rounded, hooked-under and, as it were, bony fingers'.

Whether flat or curved, many of history's greatest pianists showed no particular partiality to any finger position whatsoever. Both Liszt and Chopin appeared to adopt neutral, non-fixed, ever-changing positions. Boissier's first-hand account of Liszt's finger positions from a lesson in 1832 is revealing:

> He does not hold his fingers curved because he says that position creates dryness and he has a horror of that. Neither does he hold his hands completely flat, but his are so limber and pliable that they maintain no definite fixed position. They contact the keys in all manners and forms. (Boissier, as cited in Gerig, 1974, p. 181)

Chopin advocates a neutral anatomical starting point when writing, 'find the right position for the hand by placing your fingers on the keys, E, F#, G#, A#, B: […] this will curve the hand, giving it the necessary suppleness that it could not have with the *fingers straight*' (as cited in Eigeldinger, 1986, p. 29). In regards to these two performers, the relationship of the finger position to sound quality is seldom broached. The reason for their absence of comment is unknown, but worthy of reflection.

The uncertainty of the correlation between finger position and sound quality is compounded further when one watches video footage of pianists playing *cantabile* passages. Consider, for example, Barenboim's performance of Chopin's Nocturne Op. 27, No. 2.[22] Throughout this performance Barenboim frequently plays the right-hand melodic voice with curved fingers (that sometimes even tend towards being vertical, straight fingers). Such a posture puts the so-called 'to-be-avoided' tip of the finger in direct contact with the key surface. Horowitz's performance of the main

[22] See http://www.youtube.com/watch?v=eoBB_a61jyk

theme in Rachmaninoff's Piano Concerto No. 3 is not dissimilar.[23] He plays every single note of this *cantabile* melody with curved fingers in both hands. Similar examples can be found in *cantabile* passages of performances by other great performers, for example Vladimir Ashkenazy,[24] Benno Moiseiwitsch,[25] and Mikhail Pletnev.[26] Such examples indicate a mismatch between what is said and what is practised. Furthermore, granted that all these performances are examples of high-quality singing-tone playing, there seems to be an additional theoretical mismatch between what is practised and what is heard: curved-finger playing seems to afford a quality singing tone just as well as flat-finger playing does.

ii. Fat fingers

Occasionally, authors believe that there is a relationship between the anatomical proportions of the pianist's hands and the sound quality they produce. Lhevinne (1924/1972, p. 14) claims that '[Anton] Rubinstein had a fat, pudgy hand, with fingers so broad at the fingertips […] his glorious tone was in no small measure due to this'. Breithaupt came to a similar conclusion, stating that Rubinstein's hands were an 'absolute ideal type. Strong, padded, colossal hand with huge ridge and wonderfully massive reticulae' (as cited in Schonberg, 1987, p. 269). And Brée (1913/1997, p. 5), Leschetizky's assistant, wrote, 'The pianist will have little use for a super-refined hand, with slender shape and well-kept nails. A well-trained piano hand is broad, flexible in the wrist, equipped with wide finger-tips, and muscular.'

These arguments are barely plausible, however, if we observe the relatively normal, if not slender, appearances of both Liszt's and Chopin's hands (see plaster cast images of their hands – **Figure 1** and **Figure 2** below).

[23] See 0'54" and 15'29" of http://www.youtube.com/watch?v=lusMu2LGIUM
[24] See his performance of Chopin's Prelude no. 24 at http://www.youtube.com/watch?v=-FoABv3IhDg
[25] See his performance of Rachmaninoff's Prelude in B minor, Op. 32, No. 10, at http://www.youtube.com/watch?v=fjlltDlJSQQ&list=PLOAdj6bh1lf5d9pYw2xU8UxyuY-4xxeCi
[26] See his performance of Chopin's Preludes nos. 2 and 4 at http://www.youtube.com/watch?v=poWrXii8baI

Figure 1. Plaster cast, Chopin's hand

(Source: www.bbc.co.uk/programmes/b00rd4vd)

Figure 2. Plaster cast, Liszt's hand

(Source: Huneker, 1991)

Furthermore, Lhevinne's (1924/1972, p. 19) assertion that the 'luscious quality [of the thumb's tone is] due in no small measure to the large, springy cushion of flesh on the thumb' is illogical, for when the thumb is in its standard playing position (i.e., perpendicular to the plane of the other digits) the thick, fleshy part of the thumb barely touches the key surface.

iii. Seat height

Another area disputed in the literature, regarding the correct positioning of the body, concerns that of seat height. Seat height is a determinant of the position of the player's elbow in respect to the keyboard, and hence, the angle of the forearm in relation to the keyboard. Many assertions are made regarding the effect of this angle on biomechanics, weight transfer and sound production. There seems to be no consistency in these arguments.

Many pianists chose to address the keyboard from a high elbow position. Video footage of Arthur Rubinstein,[27] Sviotoslav Richter,[28] Daniel Barenboim[29] and Lang Lang[30] demonstrates this to be the case. Liszt, too, reportedly 'used a higher seat than many of his students later did and most pianists had before him' (Blom, 1954, p. 748). A high sitting position is often advocated in the belief that it allows more weight to be transferred into the key, and, according to supporters of the Arm-weight school, this approach seems to lead to enhanced sound quality. Other notable pianists claim that there are biomechanical limitations to sitting low. For example, Czerny (1839, p. 1) warned that 'a low seat impedes and fatigues the hands' and Brée (1913/1997, p. 5) writes, 'Too low a seat will cause increased exertion'.

The majority of pianists advocate that the elbow be kept level with the keyboard.[31] Advocates of a low sitting position, however, argue their case, coincidentally, on the same grounds as those who advocate a high seat height. Deppe, who taught to sit low, claims that 'The pianist should sit so that the forearm from the elbow to the wrist will be slightly raised – in this way the hand will remain free from any oppressive influence of the elbow' (as cited in Gerig, 1974, p. 253). Boris Berman (2000, p. 30) correlates a low sitting position to the transmission of arm weight though cautions against its excess when he states, '[the position of the elbows] should not be below the level of the keyboard to avoid introducing too much weight into the playing'. There are countless videos of famous virtuosos performing from a low sitting position. The following list of pianists is certainly no less illustrious than

[27] See http://www.youtube.com/watch?v=dFUlvEilmJo
[28] See http://www.youtube.com/watch?v=jX3ekL7AIxw
[29] See http://www.youtube.com/watch?v=FkbQrFru2Co
[30] See http://www.youtube.com/watch?v=jGSZPRk6aXA
[31] As this list is extensive, Chopin's advice (as cited in Eigeldinger, 1986, p. 28) is used as a representative example, '[to play with] the elbow level with the white keys'.

the previous list: Loius Kentner,[32] George Cziffra,[33] Glenn Gould,[34] and Vladimir Horowitz.[35]

Admittedly, there are good arguments to support the adjustment of the seat height to accommodate differences in body size and physiology and allow a comfortable hand position at the instrument. This is not the point in discussion, however. The point being considered here is whether the seat height reliably correlates to differences in sound quality. Given the conflict in the historical literature it would be perilous to support either argument unreservedly. At this point in the discussion, it is reasonable to hypothesise that seat height may act as a surrogate for some alternative biomechanical or psychological event (see Chapter 1, Part 4, Section D – Instruments, and Chapter 2, Part 2, Section E – Sound Perception).

C. Touch – The Nature of the Key Contact

Consideration will now be given to the physical contact of the finger with the key – i.e. *touch* – and its perceived influence on tone quality. This will be categorised under the following sub-headings: (i.) Key-surface noises, (ii.) Key speeds and the manner of touch, (iii.) Key-bed noises, and (iv.) Listening. These categories, despite having some overlap, are very specific and allow for a deeper appreciation of the nuances in describing touch.

i. Key-surface noises

Throughout every era, pianists have given great consideration to the noise made by the finger on the surface of the key at the moment of contact. It is, in some ways, a curiosity that it should be given any importance at all, given that the piano sound is derived from the hammer hitting the strings, not the finger hitting the key. Nonetheless, the nature of the physical contact with the key surface, and its resultant noise, is treated very seriously by pianists and, as the scientific account of sound production in Chapter 2 will reveal, not without reason. The examples given in this

[32] See http://www.youtube.com/watch?v=wPtbimvqBrQ&feature=youtu.be
[33] See http://www.youtube.com/watch?v=kpAifNIK-4Q
[34] See http://www.youtube.com/watch?v=N2YMSt3yfko
[35] See http://www.youtube.com/watch?v=-JaY0IZEy90

section demonstrate how relevant this subtopic is to a discussion of the tone-touch literature.

As might be expected, excessive percussive noises are intentionally minimised during key contact (see Part 1 – Definitions). Nineteenth-century pianist John Field, admired for his singing tone, apparently put great emphasis on this point. One of his students wrote, 'what he most disliked was a percussive attack on the keyboard itself' (Piggott, 1973, p. 105). The belief that the fleshy part of the fingertip reduces percussive noises has also already been discussed. Lhevinne gives an insight into the logic used to justify this practice by drawing an analogy between the touch of the piano key and that of the xylophone. He writes,

> If the bars of the xylophone are struck with a hard metal rod, the tone is harsh and 'metallic.' Let them be struck with a rod with the end covered with soft felt and the tone is entirely different and beautifully musical. You may not think this applies to the tone of the pianoforte, but a little experimenting will soon show that it is the case. (Lhevinne, 1924/1972, p. 14)

Note, this metaphor is physically impossible to achieve in practice, as one's finger (analogous to the xylophone rod) is not the component that contacts the strings. Thomas Fielden also believed in a soft contact with the keys, for similar reasons. He maintains that 'If the hand were a hard unyielding substance, this contact would result in a 'thud' and the consequent tone would be harsh' (Fielden, 1961, p. 53).

Sometimes, the percussive noise of the key-surface contact is deliberately encouraged, however, as Gát (1968, p. 26) writes, 'we should not renounce the tone-colouring effects attained by raising the fingers to different levels'. The default touch of the Stuttgart school obviously produced some percussive touch noises. Its founders asked that 'all the fingers must, on an average, be held firmly about one inch over the keys, […] strike rapidly and perpendicularly' (as cited in Gerig, 1974, p. 232) believing that this mode of touch contributed to a beautiful, rich tone. Deppe, conversely, argued that 'lifting the finger so high, and striking with force, stiffens the wrist, and produces a slight jar in the hand which cuts off the singing quality of the tone' (as cited in Fay, 1922, p. 288).

A more considered approach to contacting the key is frequently encouraged, the benefits of which seem to be in reducing contact noise and enhancing key control. Some authors try to evoke mental images of the fingers (and hand) gently falling onto the keys and sensitively feeling the key's resistance as it descends. The secret behind John Field's *cantabile* touch was hinted at by Glinka who observed that 'It seemed to me that he did not actually strike the keys, but that his fingers simply fell' (as cited in Piggott, 1973, p. 103). Chopin, though he would never meet or hear John Field, appeared to have taught along similar lines. He describes the moment of key contact as follows:

> the hand should fall softly on the keys […] the fingers should fall freely and lightly […] mould the keyboard with a velvet hand and feel the key rather than striking it! […] caress the key, never bash it! (as cited in Eigeldinger, 1986, pp. 30-31)

Matthay, in his *Act of Touch* (1903) systematises the idea into pedagogical method. He appropriately uses the term, 'Attention to key resistance' to describe the finger-key moment: 'correct Tone-production demands: – that the finger be brought comparatively gently into contact with the key-board surface' (p. 90).

Other pianists make efforts to differentiate between hitting and pushing the key, believing that the ideal lies somewhere in between. For example, Adolph Marx (who taught Deppe and Kullak) writes, 'the key must be felt, not pushed or struck, it must be seized with feeling' (as cited in Kullak, 1972, p. 85). Lhevinne (1924/1972, p. 21) asks to play 'as though it [the finger] were grasping the key, not striking or hitting it'. And, Thalberg asks that we should depress the keys 'by catching them closely and deftly' (as cited in Kullak, p. 90). One may ridicule the pedantry of such descriptions but such judgements should be cautioned. Clearly, these pianists were feeling something in the key (either psychologically or physically) that compelled them to try to articulate it so precisely.

Some pianists believe in minimising all key-surface contact noises in order to attain a singing tone quality. This, by definition, necessitates a pushing motion (not striking) of the fingers into the keys. Clara Schumann's father, Friedrich Wieck, advocated that 'the touch should never be audible, but only the music sound' (as cited in Fuller-Maitland, 1910, p. 344). It would appear that this method found success in Clara's playing. Franklin Taylor, a contemporary, observed that '[her beautiful tone was obtained] by pressure with her fingers rather than by percussion' (as cited in Gerig, 1974, p. 212). Some twentieth-century pianists have adopted this practice also, as Gieseking and Leimer (1932/1972, p. 22) admit, 'the tone should be produced by soft pressure, the first condition being that the finger does not leave the key at all'.

ii. Key speeds and the manner of touch

As with other aspects of technique, it is not always clear what element of the technical approach is contributing towards the tonal quality and what element is acting as a surrogate for something else. The same problem exists in regards to the manner in which the keys should be depressed. We have just looked at differences in opinion over what effect the key-surface contact noise has over sound quality. We cannot, however, be sure that this not a surrogate for key control in a more general sense. As with key-surface noises, pianists give much consideration to the speed and nature of the key descent, many of whom believe that this relates to sound quality.

With some degree of pedagogical consistency, a common goal amongst pianists who are striving to produce a singing tone, is to try to bring the key into movement slowly, smoothly, and to accompany this with some form of biomechanical shock absorbing manoeuvre. For example, Matthay (1922, p. 2) claims, 'If you want the sound to be beautiful in quality, you must set Key and String *gradually* into motion'. Lhevinne (1924/1972) goes to great lengths to avoid jolting the key into motion. He writes,

> [A singing tone depends upon] the natural 'spring' which accompanies the loose wrist (p. 25); the more spring the less bump, and it is bumps that make for bad tone on the piano (p. 19); [there should be] no spot, no

> place, no movement where the movement seemed to stop on the way down. (p. 22)

Many variables are at play here, and it is not clear which of them is actually contributing to the perceived improvement in sound quality. Is it the soft key contact? Is it the slow key descent? Why should a loose wrist be necessary for either of these to occur? The difficulty in making sense of where the causality of tone quality lies is further evidenced by teachers' insistence on controlling a specific amount of muscular tension when playing. For example, Safonoff (1915, p. 15) recommends 'an elastic fall' onto the keys; Neuhaus (1958/1993, p. 66) asks for the 'fullest flexibility [and] relaxed weightiness'; and Chopin 'repeated, without ceasing, during lessons: 'easily, easily'. Stiffness exasperated him' (as cited in Eigeldinger, 1986, p. 29). Fielden in *The Science of Pianoforte Technique* (1961) strives at an explanation, though his logic is tenuous and his scientific reasoning, superficial:

> In striking the keyboard the flexing muscles, which are supporting the blow, act as buffers in the same way, preventing a shock to the arm: they also contribute by this same action of resilience towards avoiding a thumping effect, and thereby secure greater beauty of tone. (p. 53)

Regardless of the causality, the common usage of the words, 'resilience', 'elasticity' and 'flexibility' suggests a touch form that lies somewhere between full tension and full relaxation, and, consequently, one that is sensitive to key resistance. It is difficult to find any author who expressly advocates a rigid touch to produce a singing piano tone. Breithaupt, on the other hand, in theorising the ideal state for producing the singing tone takes the idea of relaxation to an extreme when he asks that 'every movement must be supple, perfectly free from muscular contraction or stiffness, every joint, muscle and sinew of the limb being relaxed' (as cited in Gerig, 1974, p. 343). Terms can be misleading, though, and pedagogical theory can become over enthusiastic, as Lhevinne (1923, p. 7) cautions: 'the whole world has gone mad over the idea of relaxation […] there must be hand-firmness, […] there must be finger-firmness also, or there is no accuracy'.

As we shall see in Chapter 2, complete relaxation of the arm is physiologically impossible so far as playing the piano is concerned; the joints of the arm must have some degree of fixation otherwise no work can be done. Whatever the physiological explanations are, being 'flexible' and sensitive to the key's resistance appears to be one way to gain greater control of the key and thus may give the pianist the impression of manipulating sound quality.

iii. Key-bed noises

In regards to the physical touch of the finger on the key, the final component that needs to be considered is that of the effect on sound quality of the collision of the descending key with its key-bed. Not every author makes a point of this, though those who do seem to give it great importance. Again, there is conflicting opinion as to what is the desired relationship of the finger with the key-bed, and even more so regarding its effect.

Firstly, there are those that believe that when the finger travels deep into the key, (that is, to the key-bed), it correlates with a singing tone. Leschetizky recommended, '[for a singing tone] the key-surface is touched lightly and the finger then forced down by a movement of the wrist' (as cited in Brée, 1913/1997, p. 26). His student Ignaz Friedman clearly adopted the principle and passed it on to his student Mack Jost, who wrote, 'weak tone quality, [is] caused of course by not quite reaching the key-bed' (1974, p. 79).

Levinskaya (1930), a pupil of Wassili Safonoff (himself a pupil of Leschetizky), also asked that the fingers 'Go deep into the key-beds' (p. 183). She goes a step further, however, maintaining that the sound quality is enhanced by not only reaching the key-beds but by remaining in contact with them after the tone has sounded. She demanded that 'the key-bed [be] *firmly* held by the finger tip' (p. 188). This belief is expressed elsewhere in the literature, for example, by Mackinnon (1966, p. 53) who writes, 'tone may be sustained by the weight of the arm left on the key-bed' and by Fraser (2003, p. 39), who states that 'often one must really dig in to the key and hold on heartily'.

Such practice is not universally accepted. Matthay (1922) contends, 'it is wrong to squeeze the key upon the 'bed' beneath' (p. 2) on the grounds that 'anything you do to the key after that moment [that the hammer is released from the key] cannot possibly help to *make* the sound in any way' (p. 1). Berman agreed (2000, p. 12), writing 'The depth should not be exaggerated, though, as it invites pressure, which in turn produces a forced, strangulated tone', and also, 'the weight of the hands is used for the attack only, and they do not sink into the keys even for a moment' (p. 9).

In this section, touch has been dissected into its components: key-surface contact, key descent and key-bed contact. Appreciation of the physiological state of the body (joint and muscle tension) has also been considered. No agreement exists between authors in regards to the effect of touch on sound quality. As with posture and biomechanical movements, the finger-key interaction may reveal its value in its indirect effects on sound quality, that is, by enhancing key control or by simply obliging the pianist to have greater concern for the act of sound production.

iv. Listening

Notwithstanding the importance of the biomechanical aspects of technique and their necessary role in sound production, many authors deal with the inconsistencies of tone-touch theory by avoiding them altogether. Instead of giving details of specific body positions and movements, they ask that the pianist concentrate on the mental image of the sound they wish to produce, and then judge their own sound quality against it. This requires concentrated listening and a continual adjustment of one's biomechanics, in real time, whatever they should be. This is akin to saying that the end (sonic goal) justifies the means (biomechanics and touch). This way of thinking shifts the focus away from the idea that there is such a thing as an absolute tone quality, and promotes the idea that sound quality exists in the mind, in its mental image and in its realisation in a changing musical context. Thus, by this definition, sound quality is judged by its appropriateness to the musical task, not the physical process. Chopin expresses this when he states, 'The goal is not to learn to play everything with an equal sound, but rather, it seems to me, a well-formed technique that can control and vary a beautiful sound quality' (as cited in Eigeldinger, 1986, p. 31).

Pianist Vladimir Horowitz shared the same opinion, confirming that 'To be able to produce many varieties of sound, now that is what I call technique, and that is what I try to do. I don't adhere to any methods because I simply don't believe in them' (as cited in Mach, 1991, p. 117). The annihilation of the value of pedagogical methods is a consequence of such thinking, regarding which, Walter Gieseking seems passionate. He contends, 'It is useless to look for the reason of the beautiful tone in some particular finger position or hand position; I am convinced that the only way to learn to produce beautiful tone is systematic ear training' (as cited in Kochevitsky, 1967, p. 38). Even Leschetizky, teacher to so vast a number of successful twentieth-century pianists, seemed to recognise the risks of systematising technique and tone production, professing, 'I have no method and I will have no method […] Write over your music-room the motto: 'NO METHOD!' (as cited in Gerig, 1974, p. 273).[36]

The importance of listening, both to the mental 'pre-image' of the sound and the real sound, is very commonly emphasised in the literature. This simple concept demands that the pianist is constantly reviewing the sound that he makes, adjusting it in real time as appropriate to the musical context, the instrument and the performance space. Matthay (1903, p. 317) articulates this process concisely, writing that 'We must listen inwardly and outwardly, so that we hear what should be, and so that we also hear the actual result'.

This way of thinking about sound quality sidesteps, to some degree, the debate about whether an individual tone carries with it any singular tone quality – here, quality depends on how good the pre-image of the sound is and how well it is realised. Harold Bauer explains the simplicity of the approach when he challenges: 'Do you wish to make music? If so, *think* music, and nothing but music, all the time, down to the smallest detail even in technic' (as cited in Cooke, 1999, p. 77). In different words, Leschetizky (as cited in Hullah, 1906, pp. 49-50) infers the same when he states, 'decide exactly *what* it is you want […] then *how* you will do it; then play it'. Luigi Bonpensiére, a strong exponent of ideokinesis, takes this approach to its

[36]Note, although Brée's publication of Leschetizky's method, *The Leschetizky Method*, was approved by Leschetizky, its content is quite conventional and it is difficult to believe that it reflects his greater pedagogic wisdom.

extreme, bypassing the act (and difficulty!) of physical execution altogether when he states, 'I imagine the act as if already performed– and lo! it is done. My hand did it, but I did not make any effort' (Bonpensiére, 1953, p. 37).

In regards to listening to the real sound being produced, Chopin asks that the skill be cultivated to the highest level possible. He advocates to 'practise it at night in the dark! When the eyes can see neither notes nor keys, when all disappears, only then does the hearing function with all its sensitivity; then you can really hear yourself, noticing every fault' (as cited in Eigeldinger, 1986, p. 28). Gieseking and Leimer (1932/1972) believe that good technique should actually be defined by the pianist's ability to detect and correct sound faults. He writes, 'Only trained ears are capable of noticing the fine inexactitudes and unevennesses, the eliminating of which is necessary to a perfect technique' (p. 9).

The combination of a clear mental picture, astute listening and the absence of specific advice on biomechanical matters are typical of this approach to piano playing and quality tone production. Of course, tone-touch interactions are still taking place, but no deliberate concern is given to their nature – only that the musical end justifies the physical means. Pianist Leon Fleisher seems to be putting the esoteric theories of tone-touch pedagogy in their place when he states matter-of-factly, 'If you are trying to get a certain sound, you just experiment around to find the movement that will get this sound' (as cited in Mach, 1991, p. 4).

Anton Rubinstein (as cited in Bowen, 1939, p. 344) reportedly 'paid little attention to a theory of touch'. He achieved his beautiful sound 'more by willing the tone rather than by touching the key in any particular way' (p. 336). Liszt, for all his technical mastery, showed a near-total disregard for the act of teaching tone quality, the finger-key interaction or the biomechanics of playing.[37] For him, the seat of the tone-touch relationship lay in the mind, ears and spirit of the performer, not the fingers. His student, Lachmund, reflects upon the playing of his teacher and paraphrases him: 'I have always been convinced that great technique comes not so

[37] Despite the wealth of first-hand teaching material found in Jerger (1996) not one reference is made by Liszt to the physical process of tone production. All his comments pertain to musical ideas, interpretation and their transmission.

much from the fingers as from the deepest reaches of the spirit, and it is the spirit that gives technique all its strength' (as cited in Ott, 1992, p. 250).

D. Instruments – Pianos, Acoustics, Technicians

Often, pianists claim that pianos behave differently under different conditions. They assert that the means of producing a certain sound quality in one environment is different to when playing in another. Twentieth-century pianist Alfred Brendel (1976, p. 130) comments that 'anyone who has ever travelled with a piano knows that the same Steinway or Bösendorfer not only sounds different in different halls, but also seems to react differently in its mechanism'. Horowitz shows mindfulness towards the idea that the piano tone exists within a wider, performance space. He insists on the correct position of the piano on stage, claiming that 'some halls have difficult acoustics, the piano has to be properly centred on the stage, sometimes deeper or closer. But every acoustic is different. I spend hours on these things' (as cited in Dubal, 1984, p. 207). His personal piano technician, Franz Mohr (2009), confirms this statement, admitting that:

> He [Horowitz] was always fussing around with the position of the piano, moving it this way or that, an inch one way or the other, upstage, downstage, sideways. And he was always opening the curtains a bit more or a bit less. He would try every position until he was satisfied. (p. 20)

These statements indicate that performers feel that there is a relativity to any piano's sound quality and its feel. It further challenges the idea that there is a definite, absolute, way of producing a certain sound quality. This undermines the claims of much pedagogical theory. Furthermore, it challenges the idea that there is a single way of listening to a piano sound, for it exposes the precariousness of trying to draw conclusions about any single pianist's tone-touch relationship when both tone and touch are themselves relative to different performing environments. This is particularly the case in regards to studio-recorded music where the fundamental piano sound can be manipulated to an astonishing degree by the microphones, their placement, their frequency range, and their mix. Canadian pianist Glenn Gould, known for his extremely low-sitting posture, was well known for preferring the performance space of the studio rather than the live stage. He says that he enjoyed manipulating the technical parameters of the recording (and the instrument) in order to create new piano sounds (See, for example, Glenn Gould's interview where he explains his method of recording Scriabin's *Desir*: http://www.youtube.com/watch?v=JllD47HIees). One must, therefore, be hesitant in drawing conclusions about the correlation of the biomechanics of his touch to his tone quality, for example.

Evidently, pianists have a predilection for the sound and feel of some instruments more than others. This point is easily verified by the historical accounts of high-profile virtuosos touring with their own instruments, and also, the modern equivalent, of having a piano technician regulate the action and voicing of the concert piano to the performer's taste prior to each performance. Horowitz, so admired for his wide tonal palette, was particularly obsessed with the perfection of such matters. Franz Mohr, Horowitz's personal piano technician, gives many personal accounts of Horowitz's dependence on performing only on a perfectly regulated instrument. Specifically, he recalls the day when Horowitz made him famous in Berlin for saying, 'If my tuner does not come back, there will not be a second concert' (Mohr, 2009, p. 22). Horowitz was dependent on 'his' piano and 'his' technician to produce 'his' sound. The extent to which he relied upon such an extreme technical personalisation of his instrument raises questions as to what contribution his touch actually played on any individual note's sound quality. To highlight this point, the case of Horowitz is considered here in more detail.

As with Brendel's remark that the piano sound is relative to its environment, it would seem that the piano's sound, regardless of who is playing it, is heavily influenced by its technical regulation. Pianist David Wilde gives an eyewitness account of Horowitz's relationship to his piano:

> … he always played on his own instrument, a Steinway, and that instrument was voiced, tuned, regulated, and molded to suit his ear, his fingers, and his exacting taste. He preferred to play on an action with half the normal weight, with hammers so toned that the bass was gigantic: the

> descant always sang *bel canto*, and the extreme treble sparkled like *Feux d'artifice.* All this enabled him to hold his marvellously supple wrists so low that, when he wished, he could comfortably lay his whole finger-length along the key without loss of power and a mere flick of those astonishingly agile fingers could produce whatever sound he wished. (as cited in Dubal, 1993, pp. 322-323)

Claudette Sorel, who was one of the few pianists to play on Horowitz's piano, verifies the instrument's tonal and mechanical idiosyncrasies:

> I remember being enraptured by the silvery and yet sinewy sound of the piano. It required almost no effort; so light was its action that it almost played by itself […] The piano was so responsive that it almost felt as if it knew in advance what was expected of it. The magic of its sound will never leave me and will never be duplicated. (as cited in Dubal, 1993, p. 313)

Mohr, Horowitz's piano technician, provides evidence to support both these claims. He describes Horowitz's piano as follows:

> It has a very responsive action. That means that the keys go down with a light touch, there is no resistance to the fingers. And the 'uplift' to their rest position is very strong. I balanced the weight of the keys in such a way that they would function the way he wanted them to. (Mohr, 2009, pp. 25-26)

These accounts of Horowitz's piano suggest that his instrument's sound and action were modified to such a degree that the piano itself was the key determinant of tone quality. This fact raises important questions. Would Horowitz's tone have been the same if he had played on any other instrument? Was his tone a reflection of his idiosyncratic finger and wrist positions or did it occur independently of this? Is there any utility in copying his biomechanical approach? If one considers the extent to which other great pianists' instruments are regulated, one may be cautious of copying any of their biomechanics or in making any judgements about their tone-touch relationships.[38] Of course, we are not talking here of artistry or the ability of the pianist to mix multiple sounds together, but rather that the instrument itself plays a large role in defining the tone quality of the individual notes that contribute to it. Thus, in this instance, we might say that tone production lies outside of the tone-touch paradigm.

E. Psychology – The Perception of Sound Quality

Often, authors synthesise the concepts of tone and touch into one single entity: that is, one finds a similarity in their description of the sound quality (tone), the physical state of their body (touch), and the emotional state (of the music). Pianist Alexander Goldenweiser, for example, encourages the unification of the physical with the psychological when he suggests,

> … the coordination between bodily movements and sensation and the sound that we strive to project is of such importance. This affects both the visual impression made on the listener and the physical sensations of the performer, as well as the actual sound produced by the instrument. (as cited in Barnes, 2008, p. 56)

On the other hand, Abby Whiteside believes that pianists can become misguided in their interpretation of the tone-touch event if they fail to recognise the effect that the feeling of the movement has on one's interpretation of the tone quality it produces. To this effect she wrote:

> This matter of 'touch' serves as an excellent example of how influenced and often befogged our thinking is by an emotional reaction to a situation […] One presses the keybed because of emotional feeling for the tone, and the listening becomes associated with the pressure – 'touch'. The tone has not been influenced by that pressure but the performer has

[38] The list here is extensive, though the following famous pianists are known for their strict demands on piano regulation: Glenn Gould, Arturo Benedetti Michelangeli, Grigori Sokolov.

> expressed emotions with it, and thus he has been led to believe that the quality of the tone was changed by it. (Whiteside, 1961, p. 52)

Fusing the physical with the psychological is highly representative of the Arm-weight school (compared to the Finger school). To highlight this point, consider Neuhaus' advice on how to produce a singing tone: 'to get a tender, warm, penetrating tone you have to press the keys very intensively, deeply' (Neuhaus, 1958/1993, p. 72). Here, 'penetrating' tone is matched to the psycho-physical 'intensively, deeply'. One, however, could easily interchange 'penetrating' with 'intensively' and maintain the same meaning of the sentence. Curiously, Boris Berman, a product of the same Russian piano school, also merges the physical with the psychological, though he gives a different value to the concept, 'deep'. He writes, 'depth should not be exaggerated though, as it invites pressure, which in turn produces a forced, strangulated tone' (Berman, 2000, p. 12). He associates 'deep' with both 'pressure' and 'force'. There is an assumption made by these two authors that the two modalities are connected and that tone and touch are (or should be) indistinguishable in mental conception and physical reality. Although it is not clear whether this assumption is made consciously or unconsciously, it does point to a type of psychological-kinaesthetic fusion.

Sometimes this cognitive fusion results in descriptions of the tone-touch relationship that are purely metaphorical. Thalberg's description of how to produce a singing tone is extremely vivid; 'For simple, tender, and graceful melodies one should knead the keys, so to speak, pressing and working them as with a boneless hand and fingers of velvet' (as cited in Kullak, 1972, p. 90). Chopin's use of metaphor is similar. He urged his students to 'mould the keyboard with a velvet hand and feel the key' (as cited in Eigeldinger, 1986, p. 31). Adolph Marx, who taught Deppe and Kullak, also encouraged a touch form that mixed metaphor with esoteric theory. He asked that, 'each finger must be able to seize the emotional tone by itself, [and that] the key must be felt, not pushed or struck, it must be seized with feeling' (as cited in Kullak, 1972, p. 85).

It is not clear whether he is talking about a physical process, a physical sound, a kinaesthetic feeling or some other emotional-cognitive state. How should a finger 'seize the emotional tone' in practical terms? Kalkbrenner, previously criticised for his finger-isolating hand-guide device, made similar claims when he asks that 'The manner of striking the key must exhibit innumerable variations, corresponding to the various emotions to be expressed' (as cited in Gerig, 1974, p. 132). The causal link between tone and touch here is extremely ambiguous.

Alfred Brendel's description of how to create the sounds of the different orchestral instruments on the piano is a supreme example of such a mind-body-touch-tone fusion. He writes:

> The sound of the oboe I achieve with rounded, hooked-under and, as it were, bony fingers, in *poco legato* […] The pointed staccato of the oboe is pushed lightly into the keys […] The flute… wherever possible, I play every note with the help of a separate arm movement. The bassoon… the touch is finger-staccato. The noble, full, somewhat veiled, 'romantic' sound of the horn demands a loose arm and a flexible wrist […] The pianist should play harp notes with round, tensed fingers. (Brendel, 1976, pp. 95-96)

Brendel is taking the physical-sonic attributes of the orchestral instruments and translating them into finger postures. Quite how these finger postures translate into tonal differences (if at all) is not clear, however. Possibly, the strong mental and physical union of the musical concept (i.e. bassoon sound) in Brendel's mind acts as a surrogate to help him form a clearer mental image of the sound, which, in turn, augments his senses to listen, judge, and modify the actual sound when it is played. To some degree, Brendel admits this, professing that 'the resistance of the key, over and above the measurable mechanical aspect, is a psychological factor' (p. 130).

In this scenario it is possible that Beethoven might have agreed with him. We recall Schindler (1860/1966, p. 380) observing that '[Beethoven] set great store by the manner of striking the keys, and its double import: The physical or material, and the psychological'. We note the similarity between Brendel's and Beethoven's unorthodox manner of generating *legato* with 'the hand contracted as much as possible' (as cited in Gerig, 1974, p. 93). Here, Beethoven fuses the sonic concept of *legato* with the physical. The fact cannot be ignored that these great pianists were placing an importance on the psychological elements of tone production far in excess of any physical explanation. Perhaps a scientific (objective) understanding of the tone-touch relationship was superfluous to their needs as artists.

Sometimes the psychological influence is so strong that the causality of the tone-touch relationship is also described in metaphors. Deppe, one of the first and more important teachers to systematise arm weight in piano playing, suffuses metaphor with pedagogical theory. He links kinaesthetic feeling with sound quality when he postulates, 'lifting the finger so high, and striking with force, stiffens the wrist, and produces a slight jar in the hand which cuts off the singing quality of the tone' (as cited in Fay, 1922, p. 288). Here, he associates 'stiffness' with 'cutting-off' tone quality (which is not dissimilar to Berman's association of 'pressure' and 'strangulation', above). Moreover, Deppe implicates the 'stiff' wrist as something that 'cuts off' the tone. This reveals something about his understanding of tone quality causality, for to have a tone 'cut off' implies that it was in some way 'flowing' in the first place. The idea that tone (or 'energy') flows through the body is not unusual in piano pedagogy. Pianist Claudio Arrau also felt this deeply, stressing that 'if you are stiff in any joint you impede the emotional physical current of what the music dictates to you. You don't let it go through to the keyboard' (as cited in Bookspan, 1987).

Although the concept is not explicitly stated, exponents of the Arm-weight method appear to be endorsing a psychological model of understanding whereby tone starts in the back,[39] flows down through the unimpeded arm[40] and into the fingertips.[41] It is no surprise, therefore, to find that the so-called 'stiff wrist' in piano playing is anathema to the Arm-weight method. Regardless of its physical implications, the stiff wrist is rejected on theoretical grounds alone.

[39] Igumnov says, 'The source of our tone is also somewhere here in our back' (as cited in Barnes, 2008, p. 79).
[40] Breithaupt writes, 'every movement must be supple, perfectly free from muscular contraction or stiffness, every joint, muscle and sinew of the limb being relaxed', (as cited in Gerig, 1974, p. 343).
[41] Safonoff writes, 'so that the weight of the arm is felt in the finger-tips', (1915, p. 15).

The idea that relaxation allows tone to flow and that joint and muscle stiffness 'cut off' the flow is not dissimilar to other models of understanding body movement, both within and outside of piano pedagogy. Exponents of the Alexander technique, for example, would claim that spinal malalignment, particularly in the neck, or stiffness in the moving joints can block the natural coordination of movement and, hence, affect tone quality. Deborah Adams (1995) believes that,

> *Tone Production* refers to the quality of sound that is produced by descent into the key and is completely dependent upon freedom of the arm […] What is really expected is a poised and light arm, one that is supported by a back which is connected through a whole body that is fully grounded. (para. 15)

Regardless of its actual physical explanation, Deppe, like many others, believed in a holistic understanding of the tone-touch relationship, happy to allow theory to mix with metaphor and reality. Elisabeth Caland (1903, p. 19) observed that 'The fusion of these two things – i.e., beauty of movement and beauty of tone – was to him [Deppe] a law of primary importance in the art of music'.

Lastly, we examine the effect of the pianist's visual appearance on the perception of tone quality. This topic may seem to be beyond a discussion of the objective relationships existing between touch and tone, but it is not (see Chapter 2, Part 2, Section E – Visual influences). Many pianists insist on the importance of the visual appearance of movements. It would seem too that audiences like to watch their music as much as listen to it. As a basic example of this, we note how the public will always preferentially fill up the seats in the hall where the pianist's hands can be seen, before sitting elsewhere.

Just as some authors associate the physical feeling of the physical movement with sound quality, many extend this to include the physical appearance as well. Dussek, in 1796, wrote, 'as graceful for the hand, as agreeable to the ear' (as cited in Gerig, 1974, p. 123). This was echoed by Marguerite Long (1959, p. XIII) almost two centuries later who wrote, 'laid à l'oeil, laid à l'oreille [ugly to the eye, ugly to the ear]'. Surprisingly, appearances seemed to matter as much to the pianists as they did to the audiences. Amy Fay, a witness to Liszt's performances, leads one to surmise over the importance of the visual element in conveying meaning to sound. She observes that 'it is as interesting to see him [Liszt] as it is to hear him, for his face changes with every modulation of the piece, and he looks exactly as he is playing' (Fay, 1922, p. 214). And apparently it had its desired effect. 'He [Liszt] did not seem to notice the keys, but had turned his head toward us, wearing that winning smile that captivated everyone' (as cited in Ott, 1992, p. 57).

From a different era and stylistic context, F. Couperin was also aware of the visual impact of his postures. He writes,

> One should have an air of ease at one's Harpsichord; not gazing too fixedly at one object, nor yet looking too vague; in short, look at the assembled company, if there be one, as if not occupied with anything else. (Couperin, 1716/1933, p. 11)

The idea of influencing the listener's experience by providing visual clues has always been present during the history of piano pedagogy. Leschetizky believed that 'it surely does no harm to influence the listener's ear through his eye, and make the former more receptive' (as cited in Brée, 1913/1997, p. 5). Pianist Samuil Feinberg also admits to the trick when he comments that 'One of the most reliable means of achieving a singing quality in performance lies in the use of tangible expressive movements of the hand' (as cited in Barnes, 2008, p. 15). The manner in which he qualifies his opinion is of more interest, however, as it demonstrates his deep awareness of the complexity of the tone-touch problem. To Feinberg, tone and touch were in constant, two-way physical and psychological dialogue. He states, 'But one could equally maintain, conversely, that the effort to achieve a beautiful tone and cantilena stimulates efficacious movement and the physical embodiment of technical devices' (as cited in Barnes, 2008, p. 15).

5. Pedagogical Theories and their Problems

Why should there be so many theories on piano playing? Does their diversity reflect the complexity of the tone-touch relationship, or are many of them simply pedagogical ‘junk’, regurgitating accepted principles with little novel insight? An answer to this lies in understanding the motives of the different authors. Understanding their context can be as important as understanding their content.

Godowsky was always cautious of theories, and in his article, ‘The Best Method is Eclectic’ (1933) he writes, ‘unfortunately every opinion announced by any innovator immediately leads to all sorts of fallacious statements, contradictions and misunderstandings, by those who jump at conclusions’ (as cited in Gerig, 1974, p. 332). He was acutely aware of the difficulties in describing technique, and the difficulties in generalising concepts to all players in different performing contexts. Compounding this generic problem, as Chapter 2 will show, is that what is thought to be happening in theory (biomechanically or acoustically) often is not in practice. Pedagogues, in pursuit of theoretical perfection, sometimes lose touch with the practical element of playing and make claims that are based on a confusing mixture of metaphor and cognitive modelling. Whiteside, despite her strong rational beliefs in the mechanistic view of sound production – ‘one cannot ‘color’ a piano tone’ (Whiteside, 1969, p. 153) – approaches not only the irrational, but the bizarre when she posits, ‘if the pulling action of the upper arm will be the channel for emotional satisfaction, a basic rhythm, directly affecting subtlety in timing and dynamics, will result’ (Whiteside, 1961, p. 66).

Such esoteric theory is not unusual, however. Fraser, for all his goodwill in applying the Feldenkreis method, theorises that ‘Harsh tone is a result of: 1) a lack of integrity and of ‘flexible solidity’ in hand structure and 2) a lack of exactitude and accuracy in the contraction of muscles and in the control of the limbs producing the sound’ (Fraser, 2003, p. 34). It is impossible to know what this means or how it should be applied.

The interpretation of theory is made even more difficult when authors misconstrue science when trying to justify their arguments. Sometimes it is not clear whether this is done deliberately to carry more weight to their claims, or simply in ignorance with honest intentions. Nevertheless, the effect of 'quoting science' usually adds to the sense of authority to the argument, and I believe authors are not unaware of this. Matthay's (mistaken) description of the hammer-string interaction, for example, would appear authoritative to any pianist who had not otherwise invested time in learning about piano physics. He writes,

> the greater the momentum of the hammer, when it finally reaches the string, the longer will it then 'remain lying' upon the latter […] thus bringing the process into accord with Helmholtz's teaching, as to the difference in attack that causes the string to move off in comparatively *pure* (fundamental) sound rather than in harmonics of the harsher kind. (Matthay, 1903, p. 95)[42]

Levinskaya, who is neither an empiricist nor a scientist, makes claims to being scientific in her manner of reasoning. Although her conclusions are often compelling, her method is *pseudo*-scientific as it is neither derived from science nor tested by any experiment. Her speculation only serves to add to the confusion of trying to understand the tone-touch relationship. She makes the very tenuous claims that,

> the lifting of the weight and gauging the key-resistance creates a certain instability of both the hammer and the damper, which as we clearly hear has an instantaneous repercussion on the subsiding sound interfering with its *purity* and producing a kind of tremolando effect. (Levinskaya, 1930, p. 188)

In a similar way, Bonpensiére's method, mentioned earlier, which is based on principles of ideokinesis, is a purely cognitive model, untested by science (see Bonpensiére, 1953).

[42] Note, Matthay is wrong on two accounts here: the contact time of the hammer with the string is actually shorter when the hammer has more momentum; and, although this does contribute to more 'non-fundamental' harmonics, this contributes to the fullness of the sound, not necessarily its harshness, as he would believe. This is explained in Chapter 2, Part 2 – Determinants of Tone quality.

Small scientific slip-ups are also common, though probably of lesser significance. Neuhaus (1958/1993) gets muddled with Newton's 2nd Law of motion when he writes, 'if I let my hand fall on the key too fast and with too much force (the forbidden excessive '*v*' and '*h*'), I get a noise; it is no longer a tone' (p. 58).[43] Berman, though he is correct in his understanding of laws of momentum, mistakes the (hidden) contributions of mass and velocity of the entire finger-arm unit at the point of contact. He writes, 'A similar dynamic level can be achieved by using a larger joint with lesser speed, or a smaller joint with greater speed' (Berman, 2000, p. 12).[44] Lhevinne's insistence on aligning metaphor with physical reality approaches a pseudo-scientific level of reasoning when he argues that:

> If the bars of the xylophone are struck with a hard metal rod, the tone is harsh and 'metallic.' Let them be struck with a rod with the end covered with soft felt and the tone is entirely different and beautifully musical. You may not think this applies to the tone of the pianoforte, but a little experimenting will soon show that it is the case. (Lhevinne, 1924/1972, p. 14)

Ultimately, a pianist is judged by his piano playing, not his adherence to a theoretical doctrine. Breithaupt, one of the most influential of pedagogues, was never a virtuoso pianist. Levinskaya, on hearing Breithaupt play, recalls the problems this created:

> On hearing his version of correct passage playing it was so far removed from my own ideal that at once I decided to study with Godowsky […] In playing he evidently tried to follow his own precepts, and avoid all precise finger articulation. (Levinskaya, 1930, p. 57)

If Breithaupt's grand theory did not translate into success at the piano, why did he persist with it? His Arm-weight theory, with its general avoidance of the development of finger articulation, is perhaps an unconscious form of

[43] Note, the force of impact is related to the change in velocity; it cannot occur independently from it. (Force = mass x acceleration). Neuhaus need only mention '*h*' (the height of the hand above the key before it falls under gravity's influence) or '*v*' (the speed at impact), not both. He wrongly believes that their summation contributes to a summation of forces.

[44] Note, a joint that travels at too low a speed, regardless of its size, will not produce enough key speed to produce a large volume.

intellectualisation, covering up for his own lack of pianistic skill. Alternatively, one may speculate that because his professional success depended on his theory, not his playing, he was obliged to guard it in the face of opinions to the contrary. There is a danger in following a doctrine that has never been tested in practice, let alone by science. If the source of the ideas is misguided, one may well doubt the value of conclusions drawn from them. To this end, Artur Schnabel feared how Breithaupt actually acquired his ideas. He comments, '[Breithaupt] had come to the concert only to watch and, as he hoped, to establish that I played with shoulder-participation' (Schnabel, 1963, p. 161). Teresa Carreño also claimed that, 'it was after he heard me play that he wrote his famous book on 'Weight Touch'' (as cited in Gerig, 1974, p. 330). But watching is not the same as playing. As this chapter has shown, the touch-tone relationship is certainly more subtle and complex than what can be explained by observation alone.

Evidently, a large number of piano methods come from pianists who were never virtuoso pianists. In regards to Levinskaya's remarks about Breithaupt in the previous paragraph, we should be wary of theories that come from the pen of poor practitioners. Lebert and Stark (founders of the Stuttgart Finger school) were never great virtuosos either and, if anything, were cleverer at business and marketing, going to great lengths to acquire the endorsement of prominent pianists for their publications.[45] Kalkbrenner, evidently a fine pianist, was also a fine salesman and accrued a large fortune for the sales of his Hand-guide. So can what he says about technique truly be trusted? Jaynes strongly advises pianists to be careful in terms of methods and pedagogical ideology. He believes that 'Many, with ulterior motives, proceeded to embroider their 'methods' with grand, arbitrary claims – unjustified and dangerously misleading' (Jaynes, 1994, p. 619).

Similarly, Haake reflects on the success of Lebert and Stark's method with cynicism, that 'a method will always thrive on that that can be definitely projected and prescribed' (as cited in Gerig, 1974, p. 230). The propagation of Hanon's *The Virtuoso Pianist* may be explained by Haake's principles in terms of the following; (a) the exercises are very accessible, (b) they are readily applicable at all levels, and

[45] Lebert and Stark secured the written endorsement of nineteen pianists for their publication in 1870 (Gerig, p. 230).

(c) they ask for a finger touch which is easily described and easily learned. It is both remarkable, and ironic, that these exercises, written for the benefit of teaching homeless, poor children in a northern village of France (see Adams & Martin, 2009, para. 3) should have become the staple technical diet of some of piano history's greatest students at the Moscow Conservatory at the beginning of the twentieth century. Rachmaninoff recalls, 'During the first five years the student gets most of his technical instruction from a book of studies by Hanon, which is used very extensively in the conservatories' (as cited in Cooke, 1999, p. 210).

Piano pedagogy, despite its wealth of material, lacks significant contributions from many of its greatest pianists. We might reflect on this absence. Consider, for example, the following list of pianists/keyboard players who did not leave behind any systematised method on technique:

> 18th century: J.S. Bach, D. Scarlatti, G.F. Handel, W.A. Mozart.
>
> 19th century: L.v. Beethoven, F. Chopin (unpublished method), F. Liszt (wrote exercises and etudes but avoided giving specific advice on the biomechanics of technique), S. Thalberg, J. Field, Anton Rubinstein.
>
> 20th century: J. Hofmann, S. Rachmaninoff, I. Friedman, A. Schnabel, V. Horowitz, S. Richter, G. Cziffra, Arthur Rubinstein, A. Michelangeli, M. Pletnev.

Certainly all these pianists (and the countless others not included on the list) had important views and valuable tips to share – but we do not know what they were. The absence is notable for it means that the content of the literature that remains available to us is skewed. This would not be any matter of importance if the opinions found in the pedagogical literature matched those of these 'missing' pianists, but there is reason to doubt that this is the case.

There are many reasons why great pianists may not have written down their thoughts on technique. Some of these reasons may include the following: a lack of pedagogical interest or skill; a lack of personal-professional need; a lack of time; or, a lack of opportunity to publish. Possibly underlying all of these reasons, however, is one that has been raised in previous sections – that of a lack of perceived usefulness of generalised pedagogic theories. Admittedly, a certain amount of undocumented oral-aural transmission must have infiltrated piano pedagogy – the traditional pathway of communication between teacher and student – though to what extent this is true is unknown and difficult to measure.

Great pianists, perhaps inspired more by an artistic vision than a pedagogical one, learn to find their own way at the instrument, taking into account their artistic needs, their personal physiology, and the instrument's mechanical vicissitudes. Schnabel admits his ignorance about the biomechanics of technique, and says that prior to his encounter with Breithaupt, 'I had never speculated how much shoulder-participation is required, how much 'fall', 'weight', 'wrist-rolling', what elbow angles – and endlessly on…' (Schnabel, 1963, p. 161). The concerns of pianists can be strikingly different from the concerns of pedagogues. Beethoven kept a few practical exercises for himself, which he passed onto Czerny, but never wished to expand them into a theory. He feared systems and exclaimed, 'the increasing mechanism of pianoforte playing would in the end destroy all truth of expression in music' (as cited in Gerig, p. 98).

Horowitz, as we have seen, had no interest in discussing technique *per se* (or at least, not in sharing his secrets), but only in the mastery of sound production and control. This gives us the view of an artist, not a pedagogue. Leschetizky, though he endorsed the publication of *The Leschetizky Method*, written by his student (Malwine Brée), probably never truly believed in the adherence to methods. He insisted, 'I have no method and I will have no method' (as cited in Gerig, 1974, p. 273). His flexibility in giving primacy to practice not theory may explain, to some degree, his unparalleled success as a teacher.

Finally, the account of Shura Cherkassky provides great insight into the reservations that artists have about pedagogy in general:

> Teach? Never! Not for a million dollars. I don't know. I don't want to. I just don't want to. Perhaps I'm a bit selfish but I would be a terrible teacher, because while I can teach myself, if I would try to teach the same things to another person it could be rather harmful to them because it probably wouldn't suit their personality. In fact I believe to copy somebody actually does harm. Anyway, how can I tell someone how to do it when I don't know myself how I do it? (as cited in Carr, 2006, p. 42)

Chapter 2 – Scientific Perspectives

Can science help me?

As an artist I have been somewhat sceptical of the role of science in being able to help me improve my piano tone quality. But, given that the performance-based literature is so rich in its diversity of opinion as to how the tone-touch relationship operates, I wondered whether science could play a role in explaining the underlying basis for such opinions.

I have never questioned the physical explanation that the piano tone is a result of the hammer hitting the string. However, the ideas presented in the traditional literature seem to suggest that this model of understanding may be limited in some ways. Like many pianists, I have also had the feeling that something else must be being transmitted to the hammer when one plays with a deep, rich tone compared to when one plays with a lighter or more transparent tone. Clarifying such sensations has always been difficult because of their abstract and subjective nature. I now turn my focus to the scientific literature in hope that it might shed light on the problem.

1. Piano Tone and Touch: a Scientific Perspective

This chapter reviews the scientific literature on tone production and examines the evidence for whether or not differences in tone quality can be brought about by means of touch. Neither the historical nor the scientific literature disputes the fact that the quality of the tone is affected by differences in hammer velocities. However, what is disputed is whether different sound qualities can result from notes produced with the same hammer velocity, i.e. the same sound quantity.[46] Until only the most recent generation, scientists have maintained a very clinical stance on the debate:

[46] *Quality* of tone refers to the subjective description of the sound by the listener (for example, 'rich', 'deep', 'dry' etc.). It can be represented objectively by demonstrating differences in the harmonic spectra of separate piano tones. *Quantity* of tone refers purely to the measurement of sound intensity (i.e., its volume), which is chiefly determined by the velocity of the hammer at the moment of string impact.

that variations in touch only serve to alter the hammer velocity, and hence, sound quantity, and that any other characteristic attributed to the sound is illusionary. Ortmann's authoritative view, derived from his comprehensive work and experimentation on the sound and biomechanics of pianists when playing, is that '… supposedly qualitative differences as applied to the single tone are merely differences in intensity' (Ortmann, 1925, p. 26).

A minority of pianists do not dispute science's mechanistic explanation of tone production and are content to build up their pedagogic theories on it. They believe that the biomechanical role of the pianist is solely to generate different hammer speeds, and do not read anything further into the tone-touch relationship. Newman, for example, is happy to concede that 'the style of striking the key cannot affect the timbre that results, whether the striking agent be a brick, a kitten's paw, or a human finger' (Newman, 1974, p. 118). Teacher James Ching also shares the scientist's view that 'Tone quality, as a result of string vibration, is independent of the touch form used, or the manner of key manipulation' (Ching, 1946, p. 52). Pianist-teacher Gyorgy Sandor is more descriptive with his words, but accepts the same conclusion. He writes,

> All our concerns with matters of weight, mass, force, strength, tension, relaxation, fixed positions, muscles, levers, joints, bones, shoulders, arms, hands, and fingers is [sic] related to the skill and technique required to set these hammers in motion with the proper speed. (Sandor, 1981, p. 14)

The mechanistic explanation of sound production has never properly convinced the majority of pianists, however, and as a result, the two parties have often kept their scholastic distance. The suspicion that something else may be contributing to sound quality has encouraged some scientists to look deeper into the problem. More recent studies regarding the causality of piano tone quality suggest that the long-standing scientific model of understanding the tone-touch relationship is an incomplete summary of a much more complex psycho-mechanico-acoustic event. Interestingly, these later studies have served to bring the ideas of the two historically opposing parties closer together.

2. Determinants of Tone Quality

A. Hammer velocity hypothesis

The most common, traditional argument held by scientists is that the quality of the piano tone is, and can only be, a function of the momentum of the hammer. The argument is substantiated by Newton's 1st Law of Motion, and is, accordingly, difficult to refute.[47] When the law is used to explain the motion of the hammer, the explanation is as follows: that once the hammer is released from its jack, it is in free flight and its velocity will remain constant until it collides with the string.[48] As no other force can be applied to the hammer by the pianist whilst it is in free flight, the sound intensity and its quality, however defined, are both determined by the same hammer velocity – there is no other physical factor at play in the sound production process. Many authors use this argument to explain the tone-touch interaction, and in their scientific assuredness, shut themselves off from further debate. The views of Seashore (1937) are typical and are shared by Hart, Fuller and Lusby (1934), Jeans (1937), Wood (1943), and Culver (1947). Seashore states:

> It makes no difference whether the key is struck by an accelerating, retarding, even, or any form of irregular movement, the only significant thing the player controls in the stroke is the velocity of the key at the exact moment that it throws off the hammer. (p. 361)

One of the earlier piano-scientists to show empirically that hammer velocity correlated directly with changes in sound quality was White (1930). He recorded the acoustic spectra of notes played at varying volumes by several celebrated concert pianists (including Vladimir Horowitz, Harold Bauer, Joseph Lhevinne and Alexander Siloti). White found that all differences in sound quality could be

[47] Newton's 1st Law of Motion states that the velocity of an object remains unchanged unless acted upon by an external force.

[48] The exact distance of the hammer head from the string at this moment, the let-off point, varies between 1 and 3 mm (Askenfelt & Jansson, 1990a, p. 42). For a standard *forte* touch, the time interval between the hammer being released and then hitting the string is approximately 1 ms (1 ms = 0.001 s), ibid.. The velocity of the hammer varies between 0.2 m/s and 10 m/s for *ppp* and *fff* sounds, respectively – see Askenfelt and Jansson (1990a), Russell and Rossing (1998) and Goebl, Bresin, and Galembo (2005).

attributed to differences in sound intensity, and in turn, to hammer velocity. He showed that strings that were struck harder produced more (and louder) higher partial frequencies. He concluded that, 'every loudness-value has a corresponding distinct individual color-value […] there is no change of loudness without corresponding change of color […] there is no change of color without change of loudness' (White, 1930, p. 362). Even when one of his subjects claimed to be able to produce eighteen different colors for a single piano note, White could still correlate each 'color' to a distinct volume-time curve. Ortmann, in *The Physical Basis of Touch and Tone* (1925), following many years of experimentation concluded the same, that 'the quality of a sound on the piano depends upon its intensity, any one degree of intensity produces but one quality, and no two degrees of intensity can produce exactly the same quality' (p. 171).

Later in the twentieth century, Conklin (1996) showed a positive correlation between hammer velocity and sound intensity, with the decibels rising by about six degrees for every doubling in hammer velocity.[49] This of course did not preclude the possibility that variations in touch could affect changes in the acoustic spectra. It did, however, lend weight to the argument that if such tone-touch variations existed, they were occurring at an extremely subtle (or undetectable) level.

In regards to the nature of the relationship of hammer velocity to sound intensity, the scientific literature has always been in agreement: that the two have a positive correlation. One important qualification of practical importance is made here by Conklin (1996), however, who shows that increasing the key velocity will only increase the hammer velocity up to a certain point, and beyond which, any further increases in hammer velocity become minimal. The point at which no further hammer velocity (and hence no further volume) can be generated depends both on the register of the note being played and the make of the piano being played. A pianist would therefore be wise to learn to recognise where this 'cut off point' lies in order to avoid the symptom of 'overplaying' – that is, wasting physical effort on generating key speeds (and the percussive noises that goes with it) that do not translate into hammer speed.

[49] This relationship held true between the hammer velocities of 0.2 m/s (*ppp)* and 10 m/s (*fff*).

Given that Newton's laws reliably explain the motion of the hammer, why, and on what grounds, do pianists still maintain the idea that variations in touch can alter the sound quality for a given hammer speed? A possible solution lies in rejecting the scientific assumption that 'all factors are constants save only hammer-velocity' (White, 1930, p. 361) and by considering other elements of the mechanico-acoustic event. This idea is not new, just uncommon. Helmholtz (1863, pp. 74-77) for example, stressed the importance of the hammer's felt characteristics and showed how this affects the sound when colliding with the string. Bryan (1913) suggested that the movement of the hammer is more complex and proposed that they may have many smaller, undetectable vibrations that effect the sound. Also, Báron (1958) commented on the importance of the attack 'noise' element in the piano sound and considered it to be a major determinant of the standard piano tone. The influence that these physical factors, and others, have on sound quality is considered in the following section. They challenge the standard scientific explanation and point to a more complex tone-touch relationship.

B. Hammer-string interactions

Physicists, and piano manufacturers have always shown great interest in trying to understand the hammer-string interaction. It is a complex event. Many physical elements come together at this moment, some of which are partially under the control of the pianist, and others that are solely determined by the piano manufacturer or piano technician. One of the most important aspects of the hammer-string interaction is the hammer-string contact time, the main determinants of which are the hammer weight, the hammer velocity and the hammer hardness (i.e. the density of the felt).

One of the earliest published works proposing the importance of the interplay between the hammer weight, the hammer hardness and the hammer velocity on sound quality was that of the German physicist, H. Helmholtz, *On the Sensations of Tone* (1863). His work laid the foundation for many of the areas of enquiry still currently under investigation. Helmholtz observed that the piano sound is more full when the hammers of the lower octaves are heavier and covered by more felt, and the hammers of the upper octaves are lighter and covered by less felt – now a design feature of all modern grand pianos. He proposed that the hammer-string contact time was responsible for this difference in sound and that it needed to vary in proportion to the length of the string in order to achieve a full set of harmonic partials. He writes, 'the make of the hammer has an immense influence on the quality of tone' (Helmholtz, 1863, p. 77).

Recently, his findings have been substantiated. Conklin's (1996) experiments showed that 'if the hammer is in contact at the time of the first reflection [of the longitudinal wave of the string], losses can occur that cause an undesirable quality of tone' (p. 3288). Askenfelt and Jansson (1990a) quantified this difference, showing that different hammer-string contact times (as determined by hammer weight and felt thickness) effect the harmonic spectra of the tone (**Figure 3**).

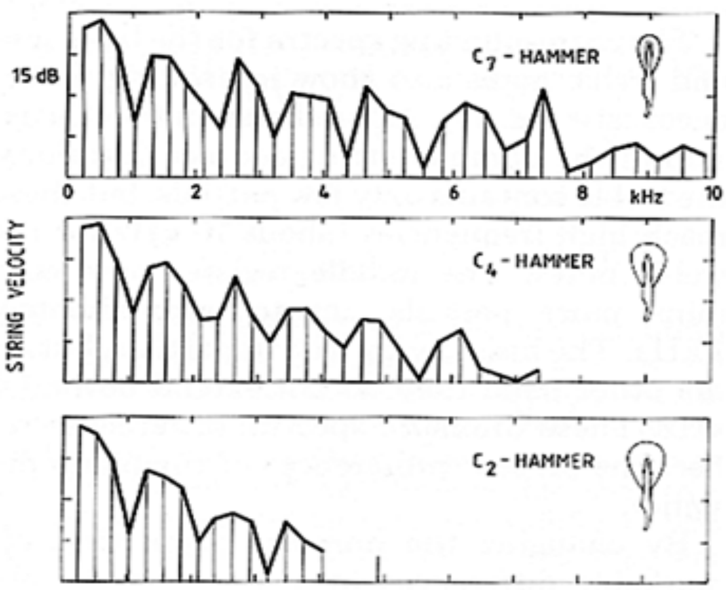


Figure 3. The effect of different hammer felt thicknesses on the harmonic spectra of the piano tone.

Using the lighter hammer with thinner felt (C7 hammer) in the C4 position produces more higher frequencies (top) compared to using the heavier hammer with thicker felt (C2 hammer), which reduces the number of higher frequencies (bottom). (Source: Askenfelt and Jansson, 1990a, p. 57)

This finding helps to explain why some pianists take such a great interest in the regulation of the hammers before a concert; their hardness affects the acoustic spectrum. The process of hardening or softening the hammers is called voicing.[50] Softening the hammer felt results in a decrease in the number of higher partials, whereas hardening increases the number of higher partials - see **Figure 4**.

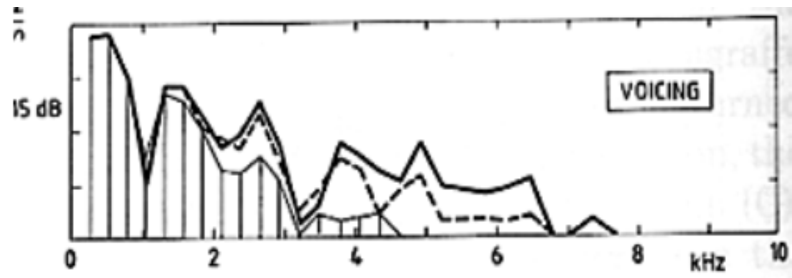


Figure 4. The effect of voicing on harmonic spectra of the piano tone.

The effect of voicing (C4, *mf*) showing spectral changes of a hard hammer (full line), a voiced hammer (dotted line) and an 'overly-voiced' hammer (thin line). (Source: Askenfelt and Jansson, 1990a, p. 58)

Most professional concert pianists will require that their piano is professionally tuned and prepared before a concert, with more notable performers also expecting that the piano be voiced to their taste prior to performance. For example, the demands placed upon the piano technician by present-day virtuoso pianist Grigory Sokolov give an insight into the importance of the matter to the pianist:

> [Sokolov] demands the absolute strictest piano regulation (using NASA level technicians who are not allowed to touch his piano stool) and requires at least twice as much rehearsal time as any other pianist (to include several hours with the technician/tuner). (cited in Rhodes, 2011)

Reportedly, 'the 'newspaper myth' about him dismantling pianos is not a myth at all: when he encounters one he's not played before, he strips it down to its tiniest parts and notes their serial numbers; only after that will he play it'. (Church, 1997, p. 15)

[50] *Voicing* involves either 'filing' away the softer outer felt to make the hammer harder or carefully piercing the felt with fine needles in specific positions to make them softer.

Franz Mohr, retired chief piano technician for Steinway and Sons, tells many anecdotes about the specific demands placed upon him by such pianists as Glenn Gould, Vladimir Horowitz and Arturo Benedetti Michelangeli. He recalls the exacting process of voicing the hammers of Horowitz's instrument (to satisfy the pianist's needs) prior to his performance of Rachmaninoff's Third Concerto in New York, confessing that 'I worked on his piano. I built up the tone. I made it as brilliant as I could […] I filed and lacquered the hammers' (Mohr, 2009, p. 127).

As mentioned, piano manufacturers choose hammers of specific weight and hardness to optimise the acoustic performance of the instrument. This results in shorter hammer-string contact times in the higher octaves and longer contact times in the lower octaves – see **Figure 5**.

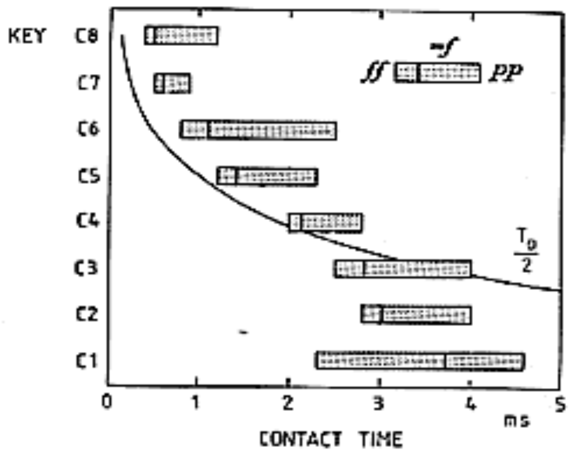


Figure 5. The effect of hammer-string contact times in different piano registers and different dynamics.

Hammer-string contact times are shorter in the higher octaves and at *ff* dynamics. (Source: Askenfelt and Jansson, 1990a, p. 49)

Independent of the predetermined factors of hammer weight and felt characteristics, when the hammer speed is higher the felt will compress more when it impacts with the string. This relative increase in hardness, as demonstrated by Suzuki (1987b) and Askenfelt and Jansson (1990a), leads to a further decrease in contact time with the string (see **Figure 6**), and an enhancement of the high-frequency part of the spectrum (**Figure 7**).

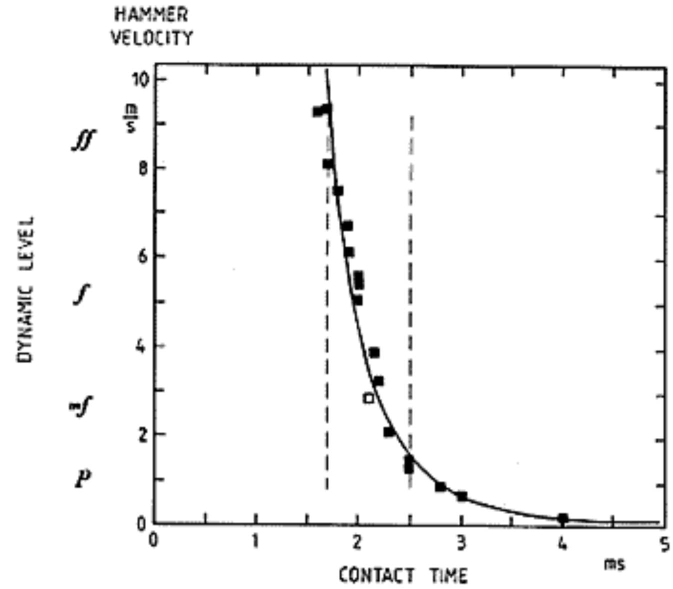
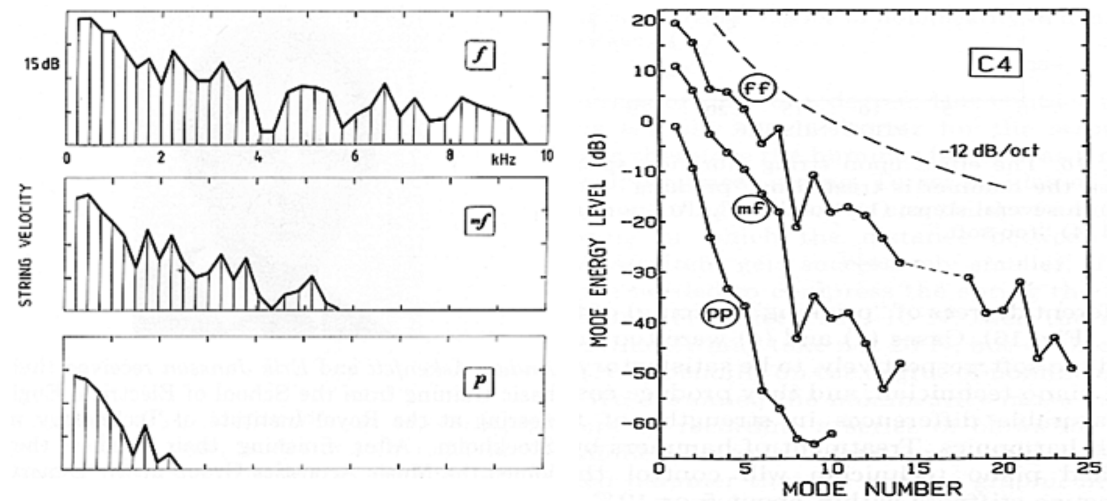


Figure 6. Hammer velocity (and dynamic level) versus hammer-string contact time.

(Source: Askenfelt and Jansson, 1990a, p. 46)



(a) (b)

Figure 7. Comparison of the spectra for a piano tone at three dynamic levels, *p – mf – f*.

Both (a) and (b) show an increase in the number and volume of higher partials with increasing dynamic (C4). (Source [a]: Askenfelt and Jansson, 1990a, p. 57; Source [b]: Hall, 1990, p. 74)

This spectral enhancement is larger in scale than that achievable by hammer exchange (**Figure 3**) or voicing (**Figure 4**) alone and, as Askenfelt and Jansson

(1990a, p. 59) suggest, is akin to having 'an automatic treble control connected to the volume knob'. Conklin (1996) concurs that the hardness gradient of the felt is responsible for the spectral changes that occur with dynamic level changes. He showed that when the hardness gradient was reduced (that is, when there was less soft, compressible felt on the outer surface of the hammer) the tones sounded 'very bright and somewhat harpsichord-like [and that] ***ff*** and ***pp*** tones had similar timbre' (p. 3290).

The same experimental findings are shared by Suzuki (1987a), Boutillon (1988), Hall (1990), and Russell and Rossing (1998), and to this end, they provide a solid body of evidence to support the argument that the hammer felt hardness is intimately linked to the acoustic profile of any given piano tone. As 'timbre independently affects the perception of emotions in music' (Hailstone, Omar, Henley, Frost, Kenward, & Warren, (2009), p. 2142), and that it is the summation of the acoustic profiles of single notes that contribute to the overall timbre of the piano sound, the importance of the hammer-string interaction must be acknowledged.

Notwithstanding this important physical relationship, that a note that is struck harder has more harmonic overtones, the main question remains: can a pianist manipulate the key in some way to produce different acoustic spectra when the hammer speed is kept at a constant?

C. Hammer vibrations

i. Mechanical differences: staccato versus legato touch

In an attempt to understand more precisely the influence that touch has on sound quality, some scientists have conducted experiments that look at both the mechanics of the piano action and the acoustic spectra when different touch forms are used. The two touches that are considered to be at opposite ends of the touch spectrum, and therefore potentially the most easy to distinguish when comparing their mechanical and acoustic profiles, are the *legato* touch and the *staccato* touch. By way of definition, *legato*, in this context, refers to notes played from the key surface, without any contact noise, and with slow, relaxed body movements.[51] *Staccato* touch, on the other hand, refers to notes played from above the key surface (and therewith, some degree of contact noise), and with a fast, short, impulsive key movement.[52] Other terms have also been used in the literature, but this does not affect the interpretation of the studies, so long as the description of the biomechanics of the movements is provided.

The choice of using the touch forms *legato* and *staccato* is based on the assumption that they represent biomechanical and acoustic opposites and are, therefore, more likely to lead to measurable differences when data is analysed. The choice is not without its problems. Firstly, to test touch forms using only two types of touch does not account for the many different shades of touch sought by the performing pianist. Nor does it account for the fact that a *legato* touch may be used (in a performing context) without having the fingers resting on the keys, or vice-versa, that a *staccato* touch be achieved with the fingers starting on the keys. Also, as we have seen in Chapter 1, there is little agreement as to what constitutes a desirable tone, and accordingly, we must take caution when generalising the findings of any single experiment to a playing context. We must also be mindful of the distinction between the *legato* touch of the experiments (the pressing down of notes without any percussion) and the concept of *legato* in music (where notes and phrases are connected by joining sounds and gestures with or without the help of the sustain pedal).

Notwithstanding these limitations, there is reasonable consistency across the literature in regards to the finer motions of the key and the hammer for the different touches. **Figure 8**, for example, compares *legato* with *staccato* touches and shows clear differences between the two. During the *staccato* touch there is a 'stop' during key descent, which correlates to a change in the velocity curve of the key, which is

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[51] A sample of the precise definitions used by authors for *legato* include:
• Askenfelt and Jansson (1991, p. 24): 'legato' – 'a relaxed touch in which the finger is resting on the key initially'
• Goebl, Bresin, and Galembo (2004): 'pressed' – 'with the finger initially resting on the key surface and pressing it down'

[52] A sample of the precise definitions used by authors for *staccato* include:
• Askenfelt and Jansson (1991, p. 24): 'staccato' – 'the key is hit from some distance above the key'
• Goebl, Bresin, and Galembo (2004): 'struck' – 'hitting the key from a certain distance above'

biphasic. Goebl, Bresin, and Galembo (2005) suggest this 'stop' is due to the compression of the parts of the action. The *legato* touch, by contrast, shows a smooth key descent and a corresponding smooth velocity increase of the key, which takes longer (20 ms) to achieve but reaches its peak velocity immediately prior to impact. These key velocity curves were also noted by Ortmann (1962, chap. 23) and Askenfelt and Jansson (1990a). They show that the hammer velocity has an early acceleration with the *staccato* touch, and a smooth, late acceleration with the *legato* touch. This most certainly plays a part in explaining other findings by Goebl et al.: that *legato* touches are used to achieve the slowest hammer velocities, *staccato* touches for the highest hammer velocities, and that no hammer velocity of greater than 4 m/s is achievable using a pressed touch. This exposes a myth so commonly found in the literature, that it is possible to play loudly without making any percussive key contact. Using *legato* touch alone, a maximum hammer velocity of only 4 m/s is achievable, which corresponds to a dynamic of approximately ***mf-f*** (see Askenfelt & Jansson, 1991; Conklin, 1996; Russell & Rossing, 1998). Faster hammer velocities require that some (percussive) key contact has occurred.

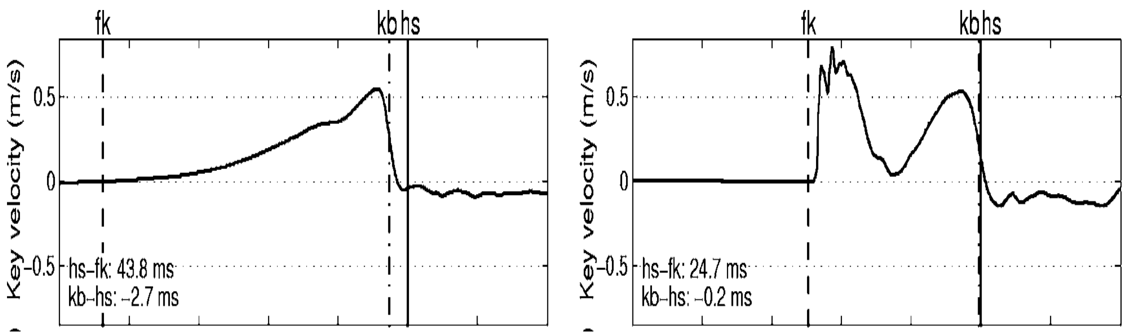


Figure 8. The effect of *legato* (left) and *staccato* (right) touches on key velocity.

(Source: Goebl, Bresin, and Galembo, 2005, p. 1158)

A change in the understanding of how touch may affect sound quality came at the end of the twentieth century when there was greater experimental precision in measuring the subtleties of hammer motion and sound waves. Limited but convincing evidence appeared showing that during flight the hammer shaft is not rigid but bends and oscillates. Notably, these shaft movements are different for different types of touch. Askenfelt and Jansson (1991) examined the hammer velocities and accelerations for three different types of touch (**Figure 9**). Unfortunately, it is not exactly clear how to classify the three types of touches they used as they do not use the standard *legato* or *staccato* definitions. Nevertheless, each touch type produced a significantly different hammer velocity and acceleration curve for the *same* dynamic outcome.

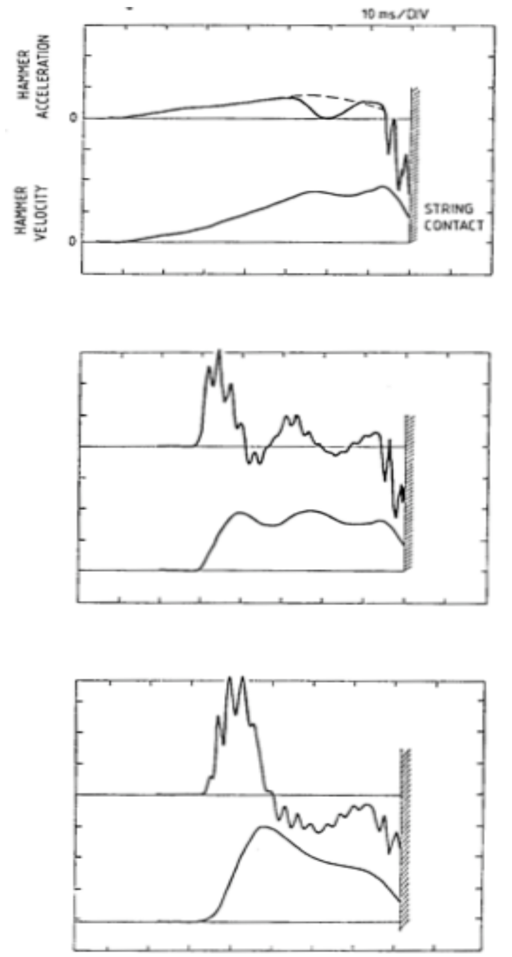


Figure 9. The influence of different types of touch on the hammer motion.

Each touch demonstrates a different velocity and acceleration curve, though at the moment of key contact each hammer velocity was the same. The pianist described the touches as 'finger only' (top), 'heavy arm with relaxed finger' (middle) and 'heavy arm with strained finger' (bottom). (Source: Askenfelt and Jansson, 1991, p. 20)

Askenfelt and Jansson (1990a) noted two different types of oscillation in the acceleration curve that appeared to correlate with distinct oscillation patterns of the hammer. For example, a slow 'backwash' of 50 Hz (shank flexes over its entire length) was associated with 'gentle types of touch', and a faster 'ripple' of 250 Hz (hammer head vibrates back and forth in the direction of the string) was associated with 'vigorous, impulse-like types of touch'. They proposed that the impulse given to the base of the hammer shaft via the jack and roller 'sets the hammer in vibration, the relatively heavy hammer head oscillating up-and-down on the flexible hammer shank.' The direction of these oscillations is shown diagrammatically in **Figure 10**. Notably, the hammer velocity profiles for the different touch forms were identical for both the professional pianists and untrained subjects.

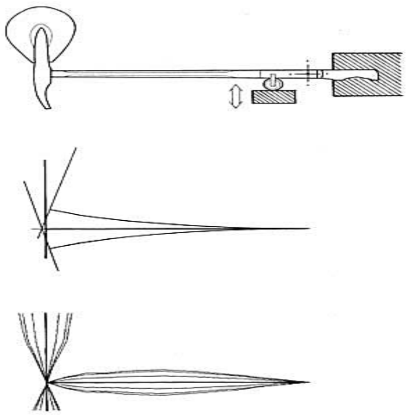


Figure 10. The 'backwash' oscillation (middle) and the 'ripple' oscillation (bottom).

(Source: Askenfelt and Jansson, 1990a, p. 51)

ii. Acoustic differences: staccato versus legato touch

Given the excitement of this new finding, that different touches actually generated different hammer motion profiles, subsequent studies attempted to answer the next logical question: did these small hammer oscillations influence sound quality? The new hypothesis was that the oscillations might cause the hammer to interact differently with the string, either by altering its angle of impact with the string or by causing a change in the amount of friction between the hammer and the string, and hence, affect string resonance. Answers to the question have been sought by scrupulously measuring the acoustic profiles of the different touch forms, and by asking blinded participants to rate the sound quality of different piano tones following listening tests.

Distinguishing between perceived differences in sound quality and measured differences is an important aspect of Askenfelt and Jansson's work. In their 1990 study (1990a, p. 49), the authors remarked that the pianist used for the study was convinced that there was a 'large difference' in the tone character whereas the experimenters in the study had the impression that the differences were 'rather subtle'. Acoustic profiles were not measured in that study, however, and so in 1991 they addressed the question directly by measuring the acoustic spectra for both *legato* and *staccato* touches. They found no difference between the two except for an increase in volume of 2 dB for the *legato* touch at partials 26 and 28, and of 4 dB at partial number 32 for the frequency range 6-8kHz. Such differences can probably be considered as being clinically insignificant, being some 50 dB less than the volume of the lower partials, and occurring in the somewhat high, fourth octave above middle C. Galembo and Askenfelt (2003) and Goebl, Bresin, and Galembo (2005) also examined the mechanics and acoustic spectra of *legato* versus *staccato* touches. They used three different makes of concert grand piano (Steinway, Yamaha, Bösendorfer) and played notes on different registers of the piano at different dynamics. Their results agreed with those of Askenfelt and Jansson in that they were unable to show any measurable acoustic different between the two touch forms. Regardless of the touch form used, tones produced with the same hammer speed produced the same sound.

A further examination of the sound spectra for *staccato* versus *legato* touches was undertaken by Suzuki (2007). His results were equivocal. He tested three notes on the piano, G3, G4 and G5, and found that the sound spectra were not statistically different for the notes G3 and G4 but that the note G5 showed an increase in volume of 1-2 dB for 6^{th}-10^{th} degree partials. This is such a very small increment that Suzuki acknowledged, '[it] might become invisible without careful graphical comparisons [of the sound spectra]' (p. 1). Notably, when the recorded notes were randomly played back to the performer, there was a negative (!) correlation between the pianist's perception of the sound quality of notes G3 and G4 and no correlation whatsoever for the note G5. In a second part to the experiment, using a group of ten non-musical volunteers, Suzuki found that a small percentage of them were able to audibly detect a difference in the sound quality for the note G5. He concluded that 'it shows, for the first time, that the touch can produce physical and psychological differences of piano tones'. But his claim is unsubstantiated and statistically insignificant (particularly when he tries to extrapolate his finding to suggest that ten per cent of the population would be able to detect such a qualitative difference).

The findings of both Suzuki (2007), and Goebl et al. (2003, 2005) need more validation. The different sound spectrums observed for *staccato* and *legato* touches were both so small, and relevant to so few notes on the piano, that one might reasonably dismiss them as being a manifestation of experimental error. A more convincing study would include a demonstration of the different sound spectra for all the notes of the instrument, reproducible on different types of pianos and in different acoustic settings. Secondly, supposing that there was a consistently measured acoustic difference for the different types of touch, this would then need to be tested on a larger sample of listeners including musicians, non-musicians, pianists and non-pianists.

Despite the initial interest in the phenomenon of hammer oscillations, no study yet reliably shows that they correspond to differences in sound quality, either by analysis of their acoustic spectra or by the subjective perception of sound by blinded listening tests. It is plausible that these oscillations might correlate to a different sense of feel in the key as the pianist presses it down, but this currently remains conjecture.

D. Extraneous sounds

An unexpected outcome of the studies which sought to measure the effect of touch on tone quality was the finding that the quality of the piano tone is affected by sounds having nothing to do with the hammer-string interaction. These extraneous sounds arise from a combination of different locations: the impact of the finger on the key surface (*finger-key* noise); the impact of the key on the keybed (*key-keybed* noise); noise within the mechanical components of the hammer action system (*action* noise); and sounds transmitted through the piano structure itself, which mainly include the keybed, rim and soundboard (*structural* noise). Structural noises occur because of the interrelatedness of the parts. Askenfelt points out that vibrations travel back and forth through the instrument in a two-way dialogue. He states 'the vibrations in the soundboard, originally excited via the strings will soon spread to the rim and keybed and vice versa, and an exchange occurs' (1993, p. 15).

Usually, a distinction is made between sounds which are desirable and those that are undesirable. As discussed in Chapter 1, desirable sounds are broadly classified as those that give the impression of a singing voice, whilst undesirable sounds are those that are percussive in nature. Extraneous noises tend to be percussive in nature and the word 'noise' is frequently used to distinguish them from the more desirable 'musical' sounds. In his summary of tone production, Ortmann (1962, p. 340) makes this distinction and states, 'Lack of percussiveness reduces the noise-element and thus permits a purer tone to be heard, but it does not affect the tone itself'.

To enforce a distinction between desirable sounds and undesirable sounds, however, underestimates the importance that noise has on characterising any instrument's sound. This idea was introduced by Báron and Hollo (1935), and Hill (1940) who strongly argued that 'a very conspicuous element in the sound produced by any instrument or voice is not tone, as such, at all but noise, pure and simple – the noise of production of the tone' (p. 248). This is an important finding, firstly, because it suggests that extraneous noises are integral to the quality of any piano tone, and secondly, because it suggests that touch may effect changes in tone quality at the finger-key moment, rather than via the key-hammer-string pathway. Again, the traditional explanation of how the tone-touch relationship operates comes under question.

i. 'Thumping'

It has long been considered by traditional pedagogy that striking the key too abruptly causes an undesirable piano sound. This sudden, percussive sound, is often called 'thumping' (see Chapter 1, Part 4, Section A - Definitions). The cause of thumping is normally attributed to a nonspecific combination of finger-key and key-keybed noises. The thumping sound, however, has recently been a focus of study by several piano scientists and it appears that it is possible to break down the sound into several different components, some of which appear to be affected by differences in touch. The two main components of the thump sound include a strong component, which coincides with hammer-string collision, and a weaker component that precedes the hammer-string collision. The latter of these appears to be touch sensitive and is, accordingly, more relevant to this discussion.

ii. The hammer-string thump component

Askenfelt (1993) demonstrates that the louder of the thump components results from the impact of the hammer with the string, not the key-keybed collision. This sound is short in duration and entirely percussive in nature, despite being derived from the supposedly useful hammer-string collision. He shows that the initial component of this hammer-string sound precedes the soundwaves of the string vibrations by a few milliseconds and is almost as loud (only 10 dB less). As the sound is relatively high in frequency (1 - 5 kHz), they propose that it correlates with the 'bite in the attack of the piano tone' (p. 18). Notwithstanding the importance of its contribution on the overall sound, its acoustic profile did not differ between *legato* and *staccato* touches; it varied only with hammer velocity.

iii. The pre hammer-string thump component: the touch precursor

Slightly weaker in intensity is the sound component that appears immediately prior to the hammer-string collision. Different names are given to this sound. Askenfelt (1993) calls it a 'touch precursor', Koornhof and Walt (1994), 'early noise', and Goebl, Bresin and Galembo (2004), 'attack noise'. Extraneous (touch) noises have also been observed by authors Boutillon (1988) and Galembo, Askenfelt, and Cuddy (1998). In terms of practical importance, the touch precursor would appear to have significance both in terms of the magnitude of its sound intensity and in its responsiveness to different types of touch. Askenfelt proposes that the touch precursor is a summation of sounds from the finger-key contact and its wave transmission through the instrument via the bridge to the strings and via the keybed into the rim and the soundboard.

Goebl et al. (2005) provide physical evidence that the touch precursor differs for different touches. They show detectable audio wave activity during the key descent phase of the *staccato* touch, but nothing detectable for the *legato* touch (**Figure 11**). They also find evidence to explain why the two touches may feel different to the pianist when played; during the *legato* touch, the key-keybed collision occurs a moment before the hammer-string collision, whereas for the *staccato* touch, the hammer-string collision is brought forward in time and the two events occur simultaneously. In other words, the temporal relationships change between the finger-key contact, the key-keybed moment and the hammer-string collision. If there is superimposition of the waveforms of the key-keybed collision with the hammer-string collision, there is reason to believe that this would also effect some acoustic change that would not have otherwise occurred if the two events were separated in time.

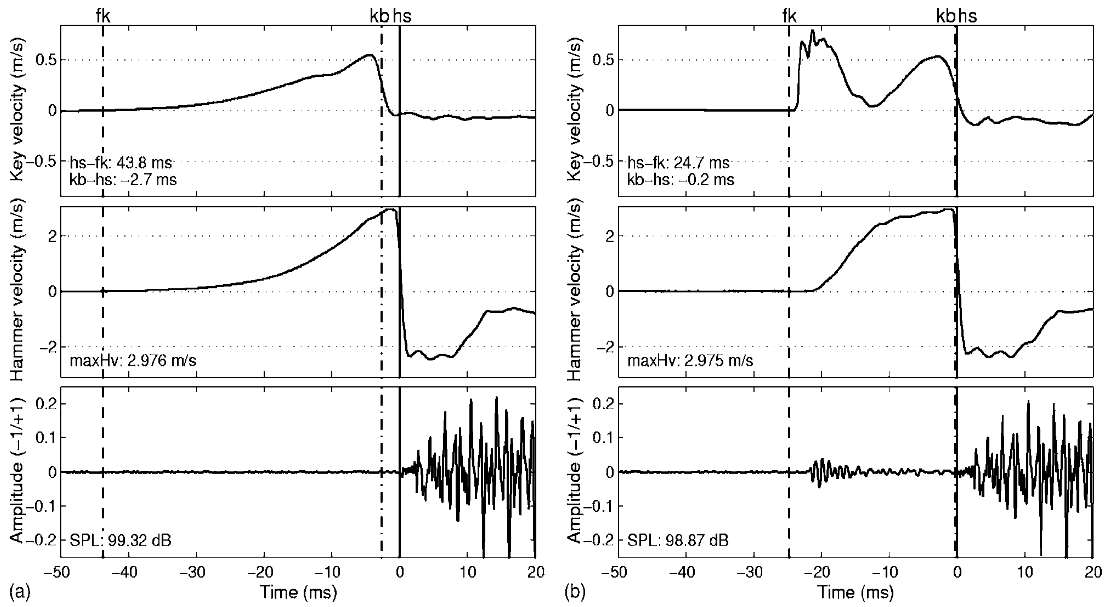


Figure 11. Audio wave and key velocity patterns (dotted line) of two piano tones with similar hammer velocity but different touches. (*legato* (left), *staccato* (right)).

(Source: Goebl, Bresin, and Galembo, 2005, p. 1158)

Askenfelt's study (1993) also shows evidence of touch precursors and that they vary depending on the touch type used. He showed that a *staccato* touch produced resonances in the bridge at frequencies of 290 Hz and 440 Hz, whereas a *legato* touch created no touch precursor at all. Vibrations generated at the bridge were found to be the same in magnitude for a ***mf*** touch precursor as those that would normally be generated when a string resonates normally at a ***pp*** dynamic. Although these touch precursors were quite soft (approximately 35 dB less in volume than the maximum piano tone produced), the fact that they appeared 20-30 ms earlier than the main string sound suggests that they may be discernible under certain conditions (Rasch, 1978). Kinoshita, Furuya, Aoki, and Altenmüller's study (2007) supports this idea, showing that when playing at a ***ff*** dynamic, the touch noise is the same in volume as a normal ***pp*** piano sound.

Of interest also was the finding by Askenfelt of two lower frequency components of the thump sound (100 Hz and 250 Hz). These were 40 dB less than the intensity of the main string resonance, were present both before and after hammer-string contact, occurred exclusively during *staccato* touch, and correlated with vibrations in the keybed and the rim. (See **Figure 12**)

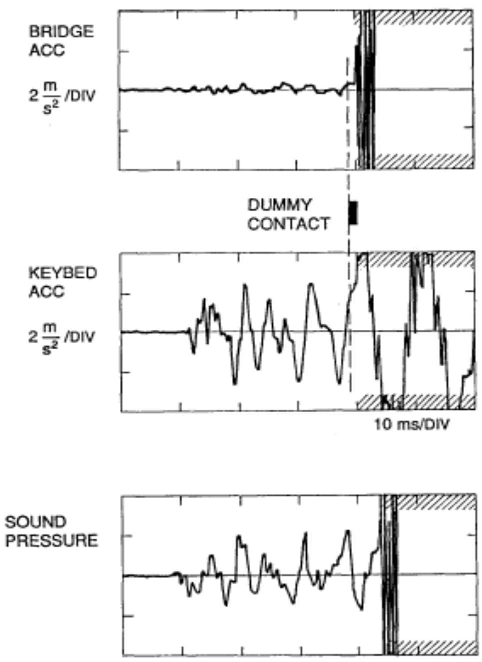


Figure 12. Vibrations at the bridge and the keybed prior to hammer-string collision for a *staccato* touch.

(Source: Askenfelt, 1993, p. 19)

The importance of the role of the keybed in transmitting touch vibrations is evident here. One of Askenfelt and Jansson's (1990a) experiments, where they artificially remove the keybed from an instrument and then play on it, reveals its importance.

The resultant sound is easily distinguished from that of the normal sound[53] – it is thin and hollow sounding and, in their words, 'resembles a plucked string' (p. 52). Askenfelt and Jansson believe that the importance of the keybed should come as no surprise, as 'the recognized piano makers select the wood for the keybed with great care in order to achieve the right 'thump' quality' (p. 52).

Equipped with evidence that the precursor touch sounds were measurably different for the different touches, though be it of small volume, Goebl et al. (2004) conducted a listening experiment to see whether the effect of the touch precursor could be audibly detected. They asked twenty musicians to listen to pre-recorded *legato* and *staccato* piano tones with and without the touch precursor sound present. They found that less that half of their listeners could reliably detect a difference between the two notes. Interestingly, two of the listeners chose correctly 80% and 86% of the time, suggesting that they may have had above-average listening abilities or a more developed ear for the piano sound, though it was not stated what musical background these listeners had. Of particular interest was the finding that when the attack noise was artificially (i.e. digitally) removed, no listener scored better than chance in guessing the correct touch.

Goebl et al. (2004) concluded that the noise of the pianist's touch clearly affected the listener's perception of the quality of the piano tone. It is a tantalising conclusion but their study has some limitations. Firstly, their data sample is so small that generalised conclusions cannot be reliably extrapolated. Secondly, the listening tests were done on volume-enhanced, recorded sounds using microphones at short range (within 20 cm), where the slightest acoustic spectral changes are more likely to be captured than in a normal acoustic. Thirdly, one may reasonably doubt the human ear's ability to perceive such small acoustic changes in a concert-hall setting when the attack sound is more difficult to hear and is heavily masked by the subsequent piano sound and the general reverberations of the acoustic space. Indeed, these very problems were explored in a pilot study by Galembo, Askenfelt and Cuddy (1998) where they asked experienced pianists to judge recorded sounds (*staccato* and *legato* touches) from microphones placed at 0.5 m and 10 m from the piano. They found a

[53] A sound-bite of this sound compared to the normal piano sound can be heard at http://www.speech.kth.se/music/5_lectures/sounds/sound_example_8.mp3

loose correlation for predicting touch differences for the 0.5 m sounds but none whatsoever for the sounds recorded at the 10 m distance.

Given that the thump sound is intrinsic to the piano sound, and given that the louder of the thump components (hammer-string impact) cannot be avoided by any means of touch (except to play softer), one may question whether the pianist should be trying to avoid the keybed thump at all. Though it seems that the surface contact noises of the finger on the key may be audible within a very close listening range, the larger of the extraneous noises cannot be reduced by any means of touch. This creates an awkward 'sound versus noise' paradox for the pianist to overcome, for to reduce the thump component is to reduce the tone (and the richness of its overtones).

Before dismissing the idea entirely that the major thump component cannot be reduced without reducing the tonal volume, I believe an alternative interpretation of the data of Kinoshita et al. (2007) may provide a small window of opportunity for the pianist to minimise the surface contact sounds without reducing tonal volume. My hypothesis is as follows. In their study, key forces were measured throughout the key's journey from touch commencement to keybed collision for soft and loud sounds. It was shown that the wasted impulse (i.e. the movement contribution that did not contribute to sound production) was 0% for soft sounds and 35% for loud sounds. Notably, some pianists in the study were able to reduce their wasted impulse for the loud sounds to 5-10%. This indicates that by some kind of (adapted) skill, some pianists could generate a loud sound whilst minimising the force impacting onto the keybed. Theoretically, by reducing the keybed component of the sound, the overall tone quality could be altered, despite the hammer velocity remaining the same. From this study, however, it cannot be known whether the pianists that demonstrated less wasted impulse were aware of it, did it intentionally or could reproduce it if asked to do so again.

Though the importance of the touch precursor cannot be definitively determined, nor its exact mechanism of action stated, it remains the only element of the touch process that has any evidence to suggest that by some means of altering the touch type, a difference in tonal quality may be effected. Whether the touch precursor can be heard, or can influence one's perception of sound quality within the milieu of other sounds in a music-making context, remains both doubtful and unproven.

E. Sound perception

If the actual contribution that the pianist makes on an individual note's sound quality is so slight, if at all distinguishable, why, as Parncutt and Troup (2002) ask, '[do] so many pianists still believe that the timbre of a piano tone depends on touch?' The answer to this question may lie in the way that humans perceive sound rather than in an explanation of the physical properties of sound production.

This section will examine the factors that influence one's perception of sound quality. Understanding these factors allows us to appreciate the tone-touch debate in a more comprehensive way. It helps to explain why pianists claim the things they do despite the unproven physical correlation of touch to tonal quality. A major concept that underlies the current model of understanding of how sound quality is perceived is that it is multimodal in nature – that is, is influenced by neural inputs across more than one sensory domain. Two areas most relevant to this research are the haptic (i.e. relating to the sense of touch – proprioception or kinaesthesia) and the visual, and the relationship that they each have on the perception of sound quality, as perceived either by the performer or the listener.

i. Haptic influences

As observed in Chapter 1 (Part 4, Section E – Psychology), for the performer, the nature of the feeling of the physical movement is often transferred onto the perception of the tone quality it produces. Because of the subjective nature of this transference, and the inability to measure any objective difference in the acoustic spectrum of the sound, piano scientists have, on a whole, dismissed its usefulness. There are, of course, many reasons besides tonal quality to adopt a certain positions and movements of the body when playing. These may include technical reasons, such as to allow greater flexibility or freedom to the playing movements (consider, for example, Chopin's comment that 'the stiff hand prevents him from playing what he would be able to manage perfectly well by being relaxed’ (as cited in Eigeldinger, 1986, p. 30), or, as many pedagogues would advocate, to allow the physical touch feeling and the emotional feeling to merge and thereby enhance the unity of the mind-body experience (recall Adolph Marx’s statement (Chapter 1, Part 4, Section C.i) that, ‘each finger must be able to seize the emotional tone by itself’). These reasons excepted, the focus here remains on whether or not these physical feelings can influence tone quality, as so many pianists would believe.

The question of tone quality at the piano, and its surrounding debate, is explained from a different perspective by musicologist Richard Parncutt. In his article (2013) he takes an original stance and posits that neither party of the tone-touch debate is necessarily right or wrong, but rather that we are all asking the wrong question. He believes that it is the inconsistency of the definition of sound quality that is to blame, and that both sides ‘fail to clearly distinguish between physical measures and descriptions of subjective experience’ (p. 1). He writes, ‘The paradox of timbre [sound quality] disappears if we accept, based on empirical evidence, that timbre generally depends on input from more than one sensory modality (weak synaesthesia)’ (p. 1), and argues that ‘we need an ecological, multimodal concept that acknowledges the role of vision, proprioception, the somatic sense, and gesture’ (p. 2).

One scientific study that supports Parncutt’s theory is that of Galembo (2001), who demonstrates that pianists’ perception of tone quality is influenced by their own proprioception (the awareness of one’s body movement or position) when playing. In Galembo’s study he used twelve professional pianists to rank the sound quality of three different makes of instrument following a short playing session. This task was considered easy by the participants and there was a notable concordance in their rankings of the instruments. Later, however, in a blinded listening experiment, when a different person played each instrument to them, none of the twelve pianists was able to identify which instrument was which. Galembo concluded that pianists find it impossible to evaluate the tone quality separately from its mechanical feel when played. He reasons that,

> the performer's judgment of the tone is affected by some touch-sensitive information, which is not available to the listener. […] For the pianist, the tone starts physically when the finger contacts the key (mentally even earlier) and includes all possible audible touch-dependent attack elements, as well as the mechanical feedback from the action via the key. (Galembo, 2001)

The influence of tactile perception on audition has also been demonstrated in other studies not involving the piano. Heller’s 1982 study (cited in Guest, Catmure, Lloyd, & Spence, 2002) is particularly relevant to the tone-touch debate. He found that the availability of auditory input did not improve subjects’ ability to discriminate between different abrasive surfaces, compared with when tactile or visual modalities alone were used. On the contrary, he found that audition was subservient to tactile and visual modalities. With respect to piano playing, we have here a further explanation as to why so many pianists insist on the full exposure of the fingertip when touching the piano key. Not only is the feedback to the sensory cortex greater when more of the finger pad is exposed to the key surface, but it would appear that the performer’s perception of sound quality is to a large extent determined by the feeling of that tactile feedback.

Interestingly, in a different study, Bresciani et al. (2005) showed that the pathway of influence can also occur in an audition-to-tactility direction. They showed that ‘Audition significantly modulated tactile perception when the stimuli were presented simultaneously’ (p. 172). This finding complements Heller’s study, rather than opposes it, and provides us with the necessary evidence to suppose that the interplay between touch perception and tone perception is two-way. Many examples of this perceptual reciprocity are found in the pedagogic literature. For example, Chopin’s advice to his students to ‘mould the keyboard with a velvet hand’ (cited in Eigeldinger, 1986, p. 31) is suggestive of a ‘tactile to audition’ directionality, whereas Berman’s claim that ‘you cannot refine your touch without refining your ear’ (Berman, 2000, p. 3) suggests the opposite directionality. Possibly, both occur simultaneously. Certainly, Neuhaus’ description of his own playing, when at its zenith, suggests that he is engaging in an auditory-tactile free-flow state that not only allows, but also thrives on multimodal sensory integration. He writes:

> when I am specially carried away and play with quite special love for music and for the piano, I am acutely aware of the pleasure I derive from the physical process of playing, the joy I feel not only in my 'soul', my ear, but in my fingers from their contact with the keyboard. (Neuhaus, 1958/1993, p. 152)

Examples of the multimodal nature of the interaction between the performer and the instrument are an extremely common occurrence in the pedagogic literature. As Parncutt (2013, p. 2) asserts, 'the perception of a motoric goal cannot be separated from proprioception [and a] pianists' perception of timbre cannot be separated from their perception of the gestures used to achieve it'.

In the context of tone-touch literature, this is an important statement. It gives a rational, scientific explanation for the deeply felt, subjective experience that pianists feel between the nature of their touch and the nature of the sound they produce. It also validates the hunch that Ortmann had early in the twentieth century that,

> [Sound] quality may well persist in the imagination of the player, reinforced, as this is, by the kinaesthetic sensations of tone-production […] the tone-quality is inseparable from the physiological sensations of the movement of tone-production. (Ortmann, 1962, p. 356)

Within this context we can now appreciate Lhevinne's obsession with maximising the sensory feedback from the fingertips: 'if we caress the key with extended or flat fingers, we evoke a sweet mellow tone' (Lhevinne, 1923). We can also understand Alfred Brendel's intuition that '[the] instrument interaction is not only a physical, but also a psychological process' (Brendel, 1976, p. 130).

Obviously, the primary reason for physical movement at the piano is to produce a piano tone, and to (try to) modify it. The traditional literature provides many different reasons why a pianist may indulge in certain movements and gestures that have no clear direct effect on sound production. Two of these reasons, traditionally dismissed by scientists, are now receiving scientific endorsement for the part they play in how the piano tone is produced and perceived. The first of these reasons has to do with the pianist's psychological linking of the physical movement to an expressive quality. The second reason pertains to the influence the pianist's visual portrayal of the sound has on the auditory perception of the audience (discussed in the next section).

Though a major skill of the pianist relates to the successful execution of complicated fine-motor tasks, his ultimate goal relates to the task of communicating: of communicating emotion and other abstract ideas through sound. Fundamental to the success of this goal is the alignment of specific expressive tasks with appropriate physical gestures. The intentional fusion of sound, speech and physical gesture has been an integral part of much of piano pedagogy. For example, Chopin considered it to lie at the core of all piano playing. In his unpublished *Méthode* he writes, 'We use sounds to make music just as we use words to make a language' (as cited in Eigeldinger, 1986, p. 42) and in regards to physical gestures he remarks, 'The wrist: respiration in the voice' (p. 45). To isolate speech from physical gesture was anathema to him.

Recent neuroscientific studies are helping to explain why pianists feel so strongly about the association between musical speech and gesture. The brain area that is involved in speech production and the syntax of language is shared with the same area that links action recognition and action production (Rizzolatti & Arbib, 1998). This same area is also found to be involved in auditory-sensorimotor integration, and, in particular, involves the supplementary motor and premotor areas, those responsible for movement planning and execution (Bangert et al., 2006). There is, it would seem, evidence of an intrinsic neural network that wires musical intention to physical movement. The fact that there is a shared feeling between the two comes as no surprise to neuroscientists Zatorre, Chen, and Penhune (2007, p. 550) who write, 'both actions and percepts depend on a single underlying mental representation'. This probably helps to explain the repulsion that many pianists feel in accepting that a *cantabile* sound can be produced as easily by 'a brick, a kitten's paw, or a human finger' (Newman, 1974, p. 118). In this example, the action of using a 'brick' is incompatible with the percept of a beautiful, singing sound.

Zatorre et al. underline the strong and complex neurological basis of the auditory-motor interaction. They offer evidence for the 'tight coupling between auditory cortices and the portions of the premotor and supplementary motor system' (p. 552). They also draw our attention to the importance of mirror neurons (located in the same area of the pre-motor cortex), stating that 'Some mirror neurons are not only activated by the observation of goal-directed actions, but also by the associated sounds produced during the action, indicating that the auditory modality can access the motor system' (p. 551).

ii. Visual influences

The neurological dialogue between, and crossing over of, the auditory and proprioceptive modalities (weak synaesthesia) helps to explain how tone quality is perceived and helps to explain many of the conflicts of opinion in the pedagogic literature. In regards to the perception of tone quality, synaesthetic connections between other modalities must also be considered. The following paragraphs examine the implications of the intermixing between the auditory and visual modes.

The way in which the pianist visually portrays the sound he produces, and the effect that this has on his listener's perception of sound quality has been recently studied in considerable detail by several authors. Throughout most of piano pedagogy, the topic has never been considered by scientists as falling under the category of the tone-touch debate. The topic has always interested pianists, however. For example, we recall the following statements from Chapter 1: 'it surely does no harm to influence the listener's ear through his eye' (as cited in Brée, 1913/1997, p. 5) and an account of Liszt performing, 'his face changes with every modulation of the piece, and he looks exactly as he is playing' (as cited in Fay, 1922, p. 214).

Along with the synaesthetic fusion of audition with proprioception, recent studies show that there is also synaesthetic fusion of audition with the visual sense. Ortmann, despite being unable to find any physical-mechanical correlation between touch and tone quality in his experiments, surmised that the explanation of the tone-touch debate could be found in an understanding of perception. He writes, 'So many qualities are read into the piano tone by the eye, and this is so often done, that it is very difficult for even an experienced listener to dissociate the two sense-impressions' (Ortmann, 1962, p. 341).

Several studies have demonstrated that the visual effect of gesture impacts on the perception of sound. Schutz and Lipscomb (2007) demonstrate in a simple experiment how the gestures of the performer create auditory illusions in the listener.[54] They found that when subjects observed the visual-audio playback of marimba players they rated the notes as being longer in duration when they were performed with a 'long' physical gesture, even when the notes had the same acoustic length. When subjects listened with audio playback alone, they could detect no difference. Also, in a second experiment, when notes of different duration were attached to the visual image, subjects were more likely to attribute the length of the note to its visual representation, regardless of its actual acoustic length.

Schutz and Lipscomb's study has important implications for the pianist within the context of accepting that the piano is a percussive instrument, the individual tone of which cannot be objectively altered following its initial strike. (Note, although the sound quality cannot be altered once struck, but for use of the sustaining pedal, Taguti, Ohtsuki, Yamasaki, Kuwano, and Namba (2002) showed that the way in which the note was stopped altered the listener's perception of the note. For example, short notes with slow decay were labelled as 'reverberating, lustrous, beautiful', whereas short notes with fast decay were labelled as 'light, sharp'.) Nevertheless, it would seem that the audience's perception of the note length is altered by the pianist's visual portrayal of it. As note length is considered to be one of the important characteristics of a singing tone, it follows that a pianist might be interested in adopting strategies that enhance it. Here, again, we find the pedagogic literature full of accounts of pianists using 'long' or 'broad' physical gestures to visually portray note length. Even though such gestures may be inefficient (from a

[54] Schutz and Lipscomb recorded audio and visual components of a professional marimba player playing long notes and short notes. There was a clear difference in the visual portrayal of the long notes (using 'long' gestures), however no acoustic difference was measurable. Schutz and Lipscomb then digitally cut out the audio components and pasted them back onto the wrong visual image. Participants were then asked to rate the lengths of the notes whilst watching the remodelled audio-visual performance or by listening to the audio alone.

biomechanical point of view), within the context of sound perception manipulation, use of such movements may be entirely justified.

The playing of virtuoso pianist Grigory Sokolov exemplifies this type of playing. Sokolov's hand and arm movements appear to serve a purpose beyond the mere biomechanical. His gestures often provide a strong visual description of the sound, and enhance the overall communication of his musical intention. Cook (2008) makes the comment about Sokolov's live performances that,

> [He] performs virtuosity as much as he performs Chopin: his hands often fly up after a particularly telling note, providing an idiosyncratic balletic correlate to the sound. His performance makes perfect sense on CD, but seeing it adds further meaning. (p. 1187)

Davidson (1993), who explores how an observer's impression of expressiveness is influenced by the visual gesture, confirms Cook's observation. She leads to the general conclusion that vision is the most effective indicator of manner and more informative than sound in forming an observer's understanding of the performer's expressive intentions. Her observations of a performance by the gesturally-rich pianist Lang Lang give further support to the idea that vision carries musical meaning (2012). She comments that pianists commonly use their hands and elbows 'to trace the contour of the music being played. This is arguably done to 'draw out' the smooth legato line that is being attempted' (Davidson, 2012, p. 598).

This may not appear to say anything about the correlation between vision and tone quality, but all things being equal, if the objective sound quality is the same, a gesture that transmits a clearer visual meaning will more likely influence the listener's perception of the sound. We are reminded of Schumann's remark about Liszt that 'if [he had] played behind a screen, a great deal of poetry would be lost' (cited in Bergeron, 2009, p. 1). Some caution is necessary here, however, for not all visual information is aesthetically pleasurable. As Shoda et al. (2007) found, 'sound with vision might not be preferred to sound only, if the visual information is disliked'.

There is further evidence of a neurological basis for the effect of vision on sound perception. In Kohler et al. (2002), their study of monkeys showed that object-related actions that are normally identified by a specific sound (e.g. paper ripping) activate the same nerves (mirror neurons) of the pre-motor cortex in the observer whether the action is performed with or without sound. This is to say that the meaning of an action can be transmitted to the observer by visual means alone. Keysers et al. (2003) supported this finding, concluding that,

> once hebbian associative learning has occurred, the sound alone, the vision alone or the motor intention alone could then evoke – as observed in our experiment – firing in such neurons even if the sound or the vision originate from someone else's movements. (p. 635)

In respect to piano playing and sound perception, we can appreciate that if a listener has previously learned to associate a certain pianistic movement to a certain pianistic tone quality, the experience of that tone quality can later be activated by the visual sense or proprioceptive sense alone.

The activation of pre-motor neurons in the observer helps to explain the relative nature of the subjective experience of sound quality. For example, if a student learns from their teacher that a singing sound is made by sitting low at the keyboard, using flat fingers and with a slow drop of the hand onto the key, the student will learn to judge sound quality according to such visiomotor parameters – as well as the usual musical parameters. According to the studies on mirror neurons, we can likely expect this same student, at any later date, to qualify sound as being singing in nature if the same visual parameters are presented again, even in the absence of sound. Equally, the converse may apply, whereby a sound may be considered to lack a singing quality, if the necessary visual stimuli are not present.

One may consider this as a basis for many of the parochial attitudes about piano technique and sound production, where many observable parameters (sitting height, wrist position, finger position, physical movements etc.) are attached to certain sound qualities, whether the sound quality is objectively present or absent. Given that the visual element so affects the perception of sound quality, and is a learned phenomenon, bias from audiences, colleagues, teachers and juries can be habitually expected. The author recalls two personal anecdotes that exemplify this point. The first relates to an experience studying with a Viennese professor who was adamant that pianists who played with a rigid, straight back – here he singled out Russians in particular, (e.g. Arthur Rubinstein (not Russian!)) – were incapable of producing a *cantabile* sound. And the second relates to the advice of a local Spanish pianist prior to a piano recital in Madrid: 'make it visual'.

Proof that the visual information influences sound perception has recently been demonstrated by a succession of authors. For reviews and meta-analyses see Spence (2007), Cook (2008), Behne and Wöllner (2011), and Platz and Kopiez (2012). One of the most recent, controversial studies is that of Tsay (2013). In her study she presented audio-visual recordings of the top three finalists in each of ten prestigious international classical music competitions to novice (no professional music background) and experts (experienced piano competition adjudicators). She found that: (a) those people who watched the performances without any audio input had the highest rate of success predicting the winners; (b) the people who had both visual and audio inputs predicted success no better than chance; and (c) those that were only presented with the audio recording predicted success below chance. (The effect held across all competitions with statistically significant p-values consistently between 0.001-0.040.) Most notably, both novices and experts predicted success to the same degree, that is, 'that novices are able to approximate expert judgments, originally made after hours of live performances, with brief, silent video recordings' (Tsay, 2013, p. 14581).

Whether the results of her study are to be taken humorously or seriously, she demonstrates, yet again, that an objective, auditory evaluation of tone quality remains a difficult task even for expert listeners. The tone-touch relationship, and the communication of it, remains a complex, multifaceted phenomenon.

Chapter 3 – Conclusions and Applications

My learning journey – The end of the debate or just the beginning?

Having reviewed the performance-based and scientific literature, I am now in a position to summarise and reflect upon how I might be able to apply what I have learned to my own performance practice. Many views have been expressed and the evidence for them has been considered. My opinion as to how the tone-touch relationship operates has evolved throughout the process and my own prejudices have been constantly challenged.

This chapter begins with a summary of the findings from Chapter 1 and Chapter 2. This is followed by a discussion of the implications of these findings and explores ways in which they may be applied to piano playing and teaching. To conclude the exegesis, the reader is invited to follow the journey that the author (the pianist) took in preparing for one of the public recitals given during the course of the research.

1. Literature Review Summary

Despite the commonly held belief that the pianist's touch can influence the quality of the piano sound (independently of its volume), this exegesis finds no reliable evidence to support a physical causality between the two. Where causality appears to exist is via the coincidental manipulation of other sensory modalities, namely vision and proprioception, which serve to influence one's perception of sound quality via a weak synaesthetic process.

In deriving this conclusion, the author has reviewed the literature on the topic of piano tone production. Special focus was given to the concept of the tone-touch relationship and the physical processes involved in the production of the piano sound. The literature was deliberately evaluated under two categories – performance-based perspectives and scientific perspectives – in order to reflect the different nature of the literature being discussed. In regards to the former, the material was almost entirely opinion-based, whereas the material of the latter was empirical and derived from scientific experiments. The inclusion of an examination of the scientific literature served two purposes; firstly, to appreciate the scientific literature in itself, and secondly, to use its findings to evaluate the validity and the applicability of traditional concepts into a modern context.

Performance-based perspectives

In Chapter 1, a diverse and conflicting range of opinions about the nature of the tone-touch relationship was presented. These opinions were first considered within a traditional pedagogical framework and later within a novel classification structure proposed by this author. The traditional framework considered touch (and sound production) to be a composite of finger-stroke and arm-weight contributions. This model provides an explanation for the relative contributions of the pianist's biomechanical movements, and also provides a crude classification of the historical developments in piano technique pedagogy.

The traditional model was shown to have several limitations, however. These were as follows. Firstly, in an attempt to understand the finer subtleties of the tone-touch relationship, the use of only two categories (finger and arm weight) was too general. The nature of the interaction is far more complex – evidenced by the variety of pedagogical opinions and the scientific findings. Secondly, the concept of Finger methods and Arm-weight methods pertain to a biomechanical function, not a tonal function. Although an association evolved between the use of arm-weight and a desirable piano tone, the association has not been universally accepted, and on the contrary, widely challenged. Thirdly, there is such heterogeneity of opinion within each of the categories that no meaningful generalisations should be made about them or in reference to them.

Given the complexity of the tone-touch relationship, and the number of variables considered to be important in the production of quality tone, a different approach was taken to classify the literature. New categories were chosen to reflect the (perceived) underlying causality of the tone-touch relationship. These categories related to the following:

i. Definitions
ii. Finger and body postures
iii. Touch characteristics
iv. Instrumental factors
v. Psychological factors

Despite some authors' efforts to define tone quality in universal terms, agreement amongst authors was not found in the pedagogical literature. More often than not, a desirable tone was one that had characteristics of a human, singing voice or, simply, one that fit the musical context. Given the frequent use of metaphor in the description of sound qualities, however, it was difficult to generalise any definition categorically. It was evident that some pianists did not believe in the concept of an intrinsic piano tonal quality whatsoever. Conversely, they believed that the idea of tone quality was objectively bound to its quantity or relative to a wider, musical context.

The idea that different finger attributes could influence tone quality was strongly maintained by many pianists. The belief that playing with flat fingers (i.e. enhancing the exposure of the pad of the finger to the key surface) enhanced tone quality was examined, but consensus of opinion was not found. The number of great pianists, who did not seem to care for this specific finger posture, equally matched those who did. A contradiction was also found amongst advocates of the flat finger position in that audio-visual footage of them playing, showed them to be using curved finger postures in places where they themselves would advocate flat fingers. The belief that fat fingers aided in the production of the piano tone was also briefly entertained but found to be an unsubstantiated assertion held by few. This was dismissed on historical grounds – that there is a comprehensive list of great pianists (including Chopin and Liszt) who have thin, slender fingers – and additionally, that there is recording evidence of contemporary performers to show that thin fingers can produce any necessary type of tone. The effect of seat height and body posture on the tone quality was also reviewed. Polarised views were found. Some gave arguments that sitting high aided the transfer of arm weight into the key and hence improved sound quality. Others, however, used the same argument to justify sitting low at the piano. Therefore, in regards to body posture and finger positioning, the traditional literature was not consistent in its opinions on what affected tone quality.

Pedagogical literature on touch characteristics was reviewed subsequently. The specifics of key-surface noises, the speed of the key depression, and key-bed noises were each considered separately. Surprisingly, there was considerable agreement amongst authors as to the conceptual goal of key depression. There was less consistency, however, in the physical description of how this should be carried out. A recurring theme amongst pianists was the aim to minimise key-surface contact noises. Suggested ways of doing this included using the fleshy part of the finger tip, making slow contact with the key, or making no percussive contact with the key. The importance that this issue held for some pianists was evidenced by their exacting descriptions of the moment of finger-key contact. These descriptions were often rich in the use of metaphor and seemed allied to a subjective feeling of the movement as much as its physical nature.

With respect to the fact that there was little agreement in the literature as to the most effective (or efficient) physical means of producing a desired tone, some pianists maintained that the cause of sound quality was probably independent of the touch moment altogether. This provided the occasion for explanations of tone quality that lay outside of the physical-mechanical pathway. The most common and consistent explanation for the cause of tone quality was, paradoxically, a psychological one: that tone quality was a function of how successfully the real, acoustic sound matched the pre-formed mental image of the sound. Within this framework, any touch form was permissible so long as the right sound was achieved. Whether different touch forms actually influenced sound quality was incidental to the process, not the primary concern. Admittedly, this explanation of tone quality shunned the core question – what are the physical means of producing quality sound? – but the universality of the opinion in the piano pedagogic literature suggests that the skill of matching the sound to the mental image is as fundamental to quality tone production as any other.

The 'special' sound quality attributed to the touch of some renowned performers was also investigated. Here, the cause of their idiosyncratic tone quality was found to be closely linked to the idiosyncratic qualities of the instrument itself. The role that the piano technician had in regulating the piano action, and particularly in voicing the hammers, seemed to be important factors in the determination of both the instrument's tonal potential and its feel when played. The influence of the hall's acoustic factors, and the manipulability of the recorded sound were also considered to be factors influencing the listener's perception of a pianist's sound quality. Understanding these factors helped to explain why associations are often made between a pianist's touch and the tone they produce, even though the cause is not one of touch.

The study also found that many authors made statements about the tone-touch relationship that reflected a synthesis of physical and psychological processes. It was a common finding that the description of the physical act of playing was similar to its musical-psychological intention. For some pianists, the feel of the physical movement of playing was not only associated with its perceived sound quality but largely defined it. Evidently, this definition of sound quality places causality into the domain of psychology and sound perception rather than mechanics. Importantly, this observation provided a basis on which to appreciate some of the more ambiguous descriptions of the tone-touch relationship; for example, when the description of causality was floridly metaphorical. Within the context of a psychological explanation of the cause of sound quality, it was noted that some authors extended this to include the influence of the visual component. For them, the visual portrayal of the intended sound quality was as important as the practical function of the movement.

A reflection on the topic of pedagogy itself was also undertaken. Here, the value of piano methods was brought into question. Many of history's most famous pianists did not write books on technique, and many of the most influential and ubiquitous piano methods were written by those who had very little experience of regularly performing concert repertoire on stage. This raises doubts as to their knowledge of the real limits (not theoretical) of the tone-touch relationship and the actual needs of the performer in such demanding scenarios. Occasionally, authors seem bound to the task of perfecting a theoretical ideal rather than attempting to deal with the solving of real, practical problems. It was noted that the motives of the some authors (i.e. personal and financial gain) did not always correlate with the needs of the pianists. Given the intrinsic difficulty of describing a highly complex physico-psychological event such as tone production, it seems reasonable to interpret all piano methods with some degree of caution.

Scientific perspectives

In Chapter 2 the scientific literature was reviewed. The focus remained centred on answering the question: how does touch influence tone quality? The position held by most scientists up until the latter parts of the twentieth century was that sound quality could not exist independently from sound quantity, namely, that one hammer speed could not produce two different sound qualities. This was called the hammer velocity hypothesis. It was substantiated theoretically by Newton's laws of motion and verified experimentally either by measuring the acoustic profiles of different notes played or by asking listeners to judge the quality of different notes played. The theory has been used by some pianists to support their own argument that the concept of tone quality is a fictitious phenomenon, though, for the greater part, the hammer velocity hypothesis has antagonised pianists, who believe that a complexity underlying the tone-touch relationship is yet to be discovered by scientists.

The interaction of the hammer with the string was shown to be an extremely important determinant of tone quality. Changes to the hammer weight and the distribution of the density of its felt effected changes in the duration of the hammer-string contact time, and in turn, effected changes in the acoustic spectrum of the resultant note. The importance of this interaction has been known to instrument makers and piano scientists for more than 150 years. Its utility to pianists, however, lies in the ability of the piano technician to voice the hammers in a way that meets the specific acoustic goals of the pianist. Hammer voicing was shown to account for the 'special' sounds for which certain high-profile pianists are known.

Despite multiple experimental attempts, no author has been able to demonstrate that the hammer-string interaction can be influenced by variations in touch (other than by increasing hammer velocity). Of interest was the finding that, for a given dynamic touch, differences could affect the velocity curves of the trajectories of the hammer and the key. It was also found that different touches could elicit distinctive vibrations in the hammer shaft. It was hypothesised that these touch dependent characteristics could explain the perceived differences in tone colour for the different types of touch. No examination was able to demonstrate such causality, either in measured acoustic changes, or in perceived quality changes, by listening. Some authors made claims that acoustic differences could be detected (measured and perceived) but these studies were significantly underpowered from a statistical point of view. The finding that differences in touch cause differences in the hammer velocity profile and in the degree of shaft vibration is not entirely insignificant; it may account for the difference in feel that pianists claim exists for the different touches.

This review also considered studies examining sounds that were not derived from the string vibration. Detailed analysis of the sound spectra of different touch forms revealed several features about the tone-touch relationship. The first important finding was that two sounds, both percussive in nature, occurred a fraction of a second before the sound of the vibrating string. The louder of these sound components was only marginally less (10 dB) in volume than the vibrating string sound. Its acoustic spectrum was not found to be influenced by touch, and the only way to reduce its volume was to play softer. It was hypothesised that this sound component accounts for the so-called 'thump' of loud playing. Notably, it was greater in volume than the sound of the key hitting the key-bed. This disproves a commonly held view that the thump sound is exclusively a key-bed phenomenon. It also challenges the idea that the thump sound is bad and has to be avoided. Certainly, the impression of thumping is undesirable in most musical contexts, but in regards to the sound production of an isolated note, whether loud or soft, the main thumping component cannot be eliminated.

The second of these pre hammer-string-collision sounds was slightly softer and lower in frequency. Of great interest was the fact that it was touch dependent. The hypothesis was that this sound was probably caused by the key-surface contact and its subsequent transmission through the instrument (including strings, soundboard, rim, keybed). This sound component, when using *staccato* touch, was audible at close range (< 0.5 m) but not when the source of the sound was further away. It is not clear, therefore, whether this sound component has any applicability to a concert performed in a large hall.

One of the most surprising findings of this research was the applicability of the findings from the fields of psychology and neuroscience to the tone-touch debate. Somewhat paradoxically, the findings from these fields helped to explain many of the pedagogical beliefs about the tone-touch relationship that the physical sciences could not. A recurring theme common to the area of psychological research was that the act of producing a piano sound and the act of judging its quality constituted a multimodal sensory process. This process was shown to integrate the modalities of touch, audition, vision and proprioception (including gesture and kinaesthesia). Consequently, some authors proposed a change in the definition of sound quality to allow it to accommodate these different modalities. To this end, there was no absolute way of measuring tone quality; it was, by definition, a subjective phenomenon.

Evidence of multimodal sensory integration was found in several studies. Tone quality was perceived differently by the pianist when playing (tactile and proprioceptive modalities present) compared to when listening (only the audition modality present). From a neurological perspective, the role of mirror neurons was implicated in the explanation of tone quality perception. Mirror neurons, which are activated when a specific action is performed or observed, were shown to arise from the same area of the brain dealing with language, gesture, motor planning, and auditory-sensorimotor integration. It was argued, therefore, that the brain intrinsically wires actions and percepts. Some studies suggest that the modality of audition and vision is also integrated into this neurological milieu. Given the complexity of the interactions, and the mixing of several sensory modalities, the idea that sound perception represents a weak form of synaesthesia was proposed.

Several conclusions can be drawn from these neuroscientific findings. Firstly, they explain why the feel of the physical movement and the feel of the touch moment are so highly valued by pianists. Secondly, they help to explain why tone quality is so commonly described using metaphors rather than precise, objective terminology. Thirdly, they provide a neurological explanation for why pianists' movements are often exaggerated from a gestural and tactile point of view, rather than optimised for biomechanical efficiency. Fourthly, they explain why the physical movement and the musical intention are so psychologically bound together, and why the perception of tone quality is inextricably linked to the nature of the movement that creates it. From a practical point of view, it is easy to see why pianists insist on a particular manner of touch to produce a particular quality of tone as the quality of the note is bound to its gesture, both musically and physically, and there are neural pathways to promote such integration. To separate the musical intention from its gesture is as awkward artistically as it is neurologically.

Finally, the impact of the visual element on sound perception was considered. This, too, influenced the perception of sound quality on the listener. When listeners were exposed to the visual gestures of pianists, their perception of tone quality (and tone length) was influenced by the nature of the gesture. The important role that gesture played in conveying meaning to listeners implicates its role in communicating tone quality as well. One author found that tone quality could be communicated to the listener based on visual information alone, independently of any audio input, and independently of the listener's pianistic ability. This further supports the role of gesture in piano playing and helps us to understand why some pianists indulge in a more extended choreography of their gestural movements when performing live.

Conclusion summary

In final summary, the scientific findings suggest that a pianist cannot influence the quality of the isolated piano tone independently of its volume in a normal performing acoustic. Two particular findings modestly challenged this conclusion: firstly, a listener may perceive differences in tone quality caused by surface contact noises and their transmission from (or through) the instrument when listening at close range; and secondly, different touches were associated with different velocity profiles of the key and the hammer, and even in the vibrational pattern of the hammer shaft. Evidence that these elements influenced tone quality (either perceived or objectively measured) was, however, inconclusive. If the definition of tone quality is extended to include tone quality perception, several factors were shown to have an influence. The influence which the sensory modalities of touch, proprioception and vision had on the perception of tone quality, were shown to be highly significant, and, given this finding, the tone-touch relationship may reasonably be considered to be a more holistic, tone-touch experience.

Further work needs to be done in quantifying the extent to which the various touch forms contribute towards one's perception of sound quality. Such studies may involve a more extended analysis of acoustic spectra, experiments involving blinded listening tests, the effects of using the sustain pedal, or other controlled studies attempting to measure the influence of the non-sonic elements on the sound quality perception. Nevertheless, this study hopefully provides an objectification of the tone-touch literature on which further studies can be based. Possible applications of these conclusions will now be explored.

2. Discussion and General Application

Up to this point, a critical review of the literature pertaining to the tone-touch relationship has been undertaken. Explanations have been provided for how this relationship operates, why such varied opinions exist, and what evidence exists to support and refute such opinions. The purpose of this section is to demonstrate how this theory may be applied to piano practice. The scope of application may be defined under the following headings:

A. Pedagogical liberation
B. Performance optimisation
   i. Optimisation of biomechanics
   ii. Optimisation of sound quality
   iii. Optimisation of live performance
C. Non-biased Teaching

A. Pedagogical liberation

One useful application of the review's findings draws on the fact that there is no agreement, or evidence, that an absolute definition of tone quality exists or that there is a universal means of producing it. Some may see this as a form of pedagogical crisis. I take the view, however, that the absence of certainty over the manipulability of the piano tone's quality gives the pianist a freedom to approach the instrument without any preconceived ideas as to how the tone-touch relationship is supposed to operate. We, as pianists, as far as tone production is concerned, may consider ourselves free of any pedagogical system and its associated biomechanical slant. This does not imply that different approaches to sound production do not have any value; it simply infers that no single method can claim authority – sound quality is a relative phenomenon, as is the means of transmitting it to the listener.

The idea that a certain posture (of body, arm, hand or finger) can manifest itself in any particular tone quality is not substantiated by the evidence. This finding is as important as it is empowering. As a pianist it allows one to feel confident that the way one sits at the keyboard is as 'right' as anybody else's way. It gives one the confidence to believe that if the sound being produced satisfies one's artistic judgment, then one need not be distracted by the advice of teachers, texts or other authorities who insist that changing one's posture can improve it. This scenario finds application in the following ways.

Firstly, it is not uncommon to have several different teachers during one's student years. The insistence from some teachers that one should change one's posture in order to produce a particular sound can be unsettling both technically and psychologically. Except in the event that the advice is directed at helping the student correct movements for other technical reasons, (see below, B.i. Optimisation of biomechanics), the advice only serves to distract the student from their musical goals, drawing their focus to something that does not need fixing in the first place. When the advice comes in the form of a public masterclass, as it sometimes does, it can be especially unsettling because it is extremely difficult to change one's technique in such a context, and because of the inference to the pianist that their posture is directly responsible for their sound quality.

These moments, as the author has previously experienced and witnessed, can be publically humiliating for the student and cause a relative destabilisation over the subsequent weeks as one doubts one's approach to tone production and technique altogether. In fairness, most masterclasses offer students ideas to consider rather than dictums to be rigidly followed, and if the teacher can guide the student to receive the advice in such a way, the masterclass experience may well help the student to explore and reflect upon the tone-touch relationship in a way not previously considered. The skill of learning to adapt ‘on the spot’ cannot be underestimated either. The conditions on stage are frequently less than ideal and one’s ability to overcome them may influence the success of the event. For example, on one occasion, the author was forced to sit on an uncomfortably low stool to make a live recording as the loud creaking of the adjustable piano bench was the only other alternative.

Secondly, in their quest to acquire a special tonal quality, students may believe that the secret of how to do it lies with a particular teacher or pedagogical method. The search for such a teacher has real implications for a tertiary student who may ultimately seek to change teachers or institutions altogether. In this scenario, the student is, indirectly, actively seeking out a particular pedagogical method, rather than passively submitting to one. The result, however, is the same: a readjustment of biomechanics that never needed to occur.

Thirdly, the insistence (from the teacher or the pianist himself) that one must follow a particular biomechanical approach in order to produce a particular sound may have further, specific, practical consequences. These relate to the futility of the exercise (as the evidence of this exegesis would suggest). For example, to spend time practicing and repeating a certain biomechanical movement under the presumption that the perfecting of the movement will correlate to the perfecting of the tone quality is misguided. It not only wastes time, but wastes effort. No amount of practice will make a single tone more beautiful on its own – piano sound quality, and its beautification, exists within a musical context (see below, 2.ii. Optimisation of sound quality). Furthermore, even if one type of biomechanical approach satisfies the needs of a given pianist, he or she still needs to be mindful of the need to adapt it to the limitations of each different instrument and performing space.

In addition, in attempting to find a particular sound quality on the piano, there is the underlying assumption that a particular sound can actually be found using the instrument at hand. As demonstrated (see Chapter 1, Part 4, Section D. Instruments), this assumption is misleading. The sound quality of any note is largely predetermined by factors intrinsic to the instrument itself (size, shape, strings, soundboard), by its regulation (hammer felt compressibility) or by the nature of the acoustic (or microphones) in which it is played. Some sounds simply cannot be made on some instruments – the intrinsic nature of each instrument is too influential. This is especially the case when one seeks a fortepiano sound on a pianoforte, or when one seeks the recorded sound of an artist such as Vladimir Horowitz or Glenn Gould whose instruments were extensively regulated and whose recorded sound was extensively manipulated by sound engineers. In such circumstances, no amount of biomechanical adaption on the pianist's part will lead him to reproduce identical tone qualities.

Fourthly, to employ a biomechanical movement, or try to adapt to one which is at odds with one's natural anatomical or physiological disposition, adds to the risk of acquiring a performance-related injury (Russell, 2006). Such injuries are, unfortunately, common and potentially debilitating (Zaza, 1998). The variation in pianists' hand sizes, finger lengths and hand spans necessitates an individualized approach to technique, not a dogmatic one (Wagner, 1988). This is common sense, though it does not always prevail, if we recall Amy Fay's experience with the Stuttgart School (see Chapter 1, Part 3, Section A. Finger methods), for example.

On the contrary, the different postures of famous concert pianists are probably, to a large extent, a natural consequence of their anatomical dispositions or simply because they 'feel right'. Again, postures may feel right out of habit or because they satisfy a musical, mechanical or performance goal. Personally, I am constantly adjusting my posture depending on the specific need at hand. For example, in playing in a large auditorium, I prefer to sit higher, with a straighter back, sometimes even tilted away from the instrument and with arms slightly straighter. I feel this allows me to appreciate the wider space of auditorium and 'feel' the sound within it whilst also providing a more authoritative visual image to the audience. I am by no means strict about this though and in different scenarios I am happy to explore the different feel that different postures afford. For example, when playing in a smaller space, or in a recording studio, I know my preference is to sit slightly lower and closer to the instrument. My findings from this investigation would lead me to believe that this is possibly because the visual element in a smaller space or in a recording studio carries less expressive importance. Regardless of the reasons, the wider point to be made is that one who wishes to copy the posture of any artist does so at their own risk – the factors that determine one person's posture do not necessarily apply to another's, and most certainly do not translate directly into equivalent piano sound qualities.

Knowing the limits of the tone-touch relationship and how it operates not only frees one from potential pedagogical restraints but also allows one to consider the question of how one can use the information to optimise playing, be it biomechanics, sound quality, technique or live performance. This is one of the most useful outcomes of this study and the next section discusses the utility of applying such knowledge.

B. Performance Optimisation

As discussed in the previous paragraphs, the finding that there is no reliable means of altering the sound quality of a note by means of touch, should free one of the obligation to submit to any predetermined, biomechanical formula. Though, simply because it does not matter how one contacts the key with the finger does not mean that there is not a better or worse way to do it. The biomechanics of a pianist have many competing interests, be they tone production, technical precision, or technical ease of movement. As mentioned from the outset, one cannot categorically dismiss the value of traditions, systematized pedagogy or expert opinion altogether. Sound production, though central to technique, is only one aspect of technique, and pedagogical methods offer a variety of information about piano playing extending beyond this singular point of focus.

However, there still remains one problem for the pianist to resolve. If no piano method can offer guarantee over the issue of quality tone production, which methods are better to follow? Does one method afford an ease of tone control more than another? Some methods probably will, for some people, but others may not. As we have seen, expert pianists differ in their opinions, and the question of how to play in the easiest way to achieve any given effect now comes to the fore.

i. Optimisation of biomechanics

If the concept of artistry is removed from the tone-touch equation, the tone-touch event may be objectively considered to be a purely mechanical one. As such, the event can be explained by the laws of physics and may be optimised according to such laws. Most importantly, the pianist should recognise that there is no conflict of interest between achieving his artistic vision of sound and applying the laws of physics to optimise his biomechanics. On the contrary, my argument is that both issues should be addressed with maximum attention to detail.

On a personal level, to feel free to apply the laws of physics to optimise my technique without the fear that I am in some way compromising my sound quality has been extremely useful. I have done this throughout the period of this research and the results have been beneficial. The confidence to let go of an old way of playing because of the belief that changing the movement would negatively affect my sound has helped me correct a number of biomechanical issues, all of which have resulted in an improvement of sound control and a reduction in muscular effort. Interestingly, from a different perspective, one may elect to not change one's biomechanics, even if they are not optimised, and remain confident in doing so, for bad biomechanics do not equate to bad tone quality (even though they might equate to bad piano playing in general). This choice can be elected if one is happy with the *status quo* of their playing, or if they are happy to compromise biomechanics for other gains, such as an exaggeration of physical gestures during live performance to communicate meaning.

Unfortunately a detailed discussion of biomechanics is beyond the scope of this dissertation. The reader, if interested, however, may refer to Ortmann (1962) where he discusses in detail the proper application of Newton's laws of motion (i.e. the principle of inertia and the law of momentum conservation) and the anatomical and physiological workings of the human body as they apply to piano playing, particularly those concerning ideal joint positions and the integrative function of muscles during playing (pp. 40-63).

Optimising the biomechanics of playing, as they apply to each individual, is an area of pedagogy deserving of closer attention. As the limits of sound production are known and the laws that guide human movement are known, each pianist has the potential to optimise their movements in a way that serves any particular goal. Such goals may include the elimination of 'unproductive' movements, the acquisition of 'maximally-productive' movements (i.e. maximum efficiency and effectiveness), the avoidance of movements risking fatigue or injury, or, if nothing should concern the pianist, a choice to ignore such principles of application altogether. (Although the latter point appears to contradict the overall argument, the author believes that it is an important factor to consider, especially in the context of teaching where it may be better to allow a student to develop in their own way rather than bring focus to a small biomechanical issue that is either harmless or may naturally resolve itself).

ii. Optimisation of sound quality

An appreciation that sound quality on the piano is a subjective experience that is relative to a musical (and visual) context, rather than the result of any specific touch characteristic, allows us to approach sound production in a slightly different way. The removal of the idea that any single piano note carries intrinsic quality allows, and demands of, the pianist to find alternative means of conveying quality. Paradoxically, this can be one of the most helpful stimuli for a pianist to improve their overall presentation of sound at the piano. For example, instead of relying on an unproven belief that a particular sound will be beautiful simply because it is struck in a certain way or with a certain posture, a pianist may now be forced to listen more carefully to the sound they are making and find beauty in it by manipulating the context in which all the sounds are placed.

Indeed, the illusion that any particular sound quality exists at all on the piano is the result of an ever-changing blend of sounds (and silences) in relation to the ever-changing musical discourse. It may be argued that one of the distinguishing features of a master pianist is their ability to create sound illusions, which are both fantastic (imaginative) and appropriate (musically sensible). Fundamental to the ability to create any 'special' sound is one's ability to listen and respond appropriately to it. It is not surprising, therefore, that so many of the great pianists ask that the skill of listening be cultivated to the highest possible degree. In this regard we recall the advice of Chopin, Gieseking, Neuhaus and others (Chapter 1, Part 4. Section C.iv. Listening). In turn, it is perhaps no coincidence that those pianists who are focused so intensely on the sounds which they are making, become so skilled at controlling them – their great techniques develop from their superior listening skills, not their adherence to traditional doctrines on biomechanics.

The idea that cultivated listening precedes a cultivated technique is supported by other findings from this research. Bound to the idea of listening to the actual sound, is the idea of 'listening' to the mental image of the sound before it is produced. As the mental image is only as good as one's ability to create it, we recognise here the importance of developing one's musical imagination. This reminds us of, and justifies, the use of metaphor in teaching pianists how to think about the piano sound. For example, Anton Rubinstein's remark that the piano is 'a hundred instruments' (as cited in Neuhaus, 1958/1993, p. 55) or Chopin's advice to 'listen frequently to Italian singers […] one should follow that of Pasta' (as cited in Eigeldinger, 1986, p. 44) are ways to broaden one's musical imagination.

Thus, when playing, the mental image should be the goal to which the physical execution strives, with the actual sound constantly being matched against that of the mental image. This paraphrases the advice of Matthay, Leschetizky and Gieseking (see Chapter 1, Part 4, Section C.iv. Listening) and many others. That this approach to sound production should represent the inner pathway towards the realisation of any piano sound should be an important reminder to all pianists that sound quality is a consequence of great musical imagination and concentrated listening, not simply biomechanics, regardless of their degree of optimisation. This possibly explains why great pianists are not always interested in teaching technique, for to them, the ability to listen to one's musical vision is what matters, not the details of how. An appreciation that piano tone quality is not an absolute entity underpins this argument.

In a different context, it is important to remind oneself that the tonal possibilities of each instrument are different and unique to the instrument being played. This has important implications when preparing repertoire in the practice room and bringing it to the concert stage. The findings from this paper suggest that one would be naïve to presume that the sound capabilities of one instrument would be reproducible on the other. Accordingly, one should not get too frustrated when it happens. Every instrument is different in terms of its make, size, hammer regulation, soundboard quality, mechanical feel, overall sonority and the environment in which it is placed. Some sounds simply cannot be made on some instruments and it is futile to attempt to try. Experienced pianists know that even when instruments may be expected to be similar (e.g. Concert D sized Steinways), they rarely are, and even instruments that are similar, may be different when placed in different acoustics (see Chapter 1, Part 4, Section D. Instruments).

The relative nature of the sound and feel of each piano should be taken into account by the pianist when preparing and performing their repertoire. This may take many forms. Firstly, the performer should make an effort to find out about the concert instrument and the acoustic in which it will be played. Practising on an old, upright piano in a small, dry acoustic has little relation to performing on a finely regulated Steinway in a large concert hall. The pianist would be misguided to believe that the same sounds will be achievable in the two different scenarios and should therefore not be complacent to believe so. Efforts should be made to practice as though it were the concert scenario, or as a reasonable compromise, with a view to the concert scenario. This will most likely necessitate both mental and physical adjustments in the way of being flexible in one's image of the sound, flexible in one's voicing and balance of the sound, flexible to use the pedal differently, flexible to use different touches and flexible to adapt to a different mechanical feel. This in turn may require practising the above-mentioned elements in different ways, and perhaps on different instruments.

One may also wish to mentally prepare for factors that are out of one's control on concert day. The ability to fore-plan and adapt (rather than make excuses) are characteristics of professional pianists. They may extend also into other professional behaviours that involve arriving early at the concert venue to have adequate time to adjust to the instrument in its acoustic, or, when the service is available, to have the piano technician make adjustments to the instrument so that it better matches the pianist's personal tastes. This author has sometimes changed his repertoire to avoid the artistic disappointment of having a certain piece performed on a piano or in an acoustic that does it no justice.

Finally, as briefly mentioned, acceptance that touch qualities may not be reflected in the piano tone quality demands that the pianist gives more focus, not less, to the task of sound organization, interpretation and listening. It is beyond the scope of this paper to discuss all the elements at the pianist's disposal in regards to influencing the listener through the manipulation of sound – this is a topic for the art of piano playing and interpretation in general. Notwithstanding, there are some points to be made as to their relationship with tone-touch pedagogy.

Some elements that pianists typically use to create the illusion of different sound qualities are related to the organization of sound into various layers (through dynamic, register or textural distinction), the exploitation of dynamics and accent, and the contrasting of 'blocks' of sound over varying temporal lengths. Where a singing tone is required, any form of sonic manipulation replicating the human voice is usually advocated: either by emphasising the length of notes, highlighting the contours of the phrases or by mimicking breathing patterns and air flow by the use of *rubato* in the melody or accompaniment figurations. Specific examples of how these elements can be used when playing are discussed below (see Part 3. Sound Quality and the Singing Tone).

iii. Optimisation of live performance

The finding that the perception of tone quality is influenced by factors beyond the physical tone-touch relationship provides further opportunities for the pianist to optimise performance. We recall that the experience of tone quality may be influenced by the inputs of several sensory modalities including proprioception, somatic senses, gesture and vision (Parncutt, 2013). A pianist, acknowledging this, may choose to manipulate such modalities to his advantage. For example, one may wish to explore the interplay between the feeling of the touch, its gesture and the visual portrayal of the sound. Though the effect these elements have on sound quality is discredited by believers of the hammer velocity hypothesis (see Chapter 2, Part 2, Section A. Hammer velocity hypothesis), the application of such concepts to piano tone production is not new to piano pedagogy and has a selected role in both practice and performance.

Firstly, let us consider how a pianist may explore the interplay between the feeling of the touch and the desired sound quality. Acknowledging that the experience of sound quality is itself influenced by the sensory inputs of touch and proprioception, a pianist may choose to deal with such influences in one of two ways – either by enhancing or restricting them. By choosing to indulge his or her senses further, a pianist may add to the holism of the sound experience. This might be achieved by enhancing the contact surface area of the fleshy part of the finger-tip with the key (e.g. Lhevinne), by exaggerating the physical gesture of the sounds being expressed (e.g. Sokolov), or by giving more focus to body awareness and the quality of the movements being made when playing (e.g. principles of Alexander technique). Such common practice techniques may help the pianist to form a more vivid mental image of the sound – as it were, a form of self-suggestion – and in turn, be more likely to 'find' the sound with their fingers.

Conversely, a pianist may try to minimise the influence of such sensory inputs based on the rationale that they may distort his ability to judge the sound quality objectively. This, for different reasons, may help the pianist 'find' the right sound more than he would have if he had been 'under the influence' of the exaggerated sensory feedback. There is no reason to think that one approach has more or less utility, or that such a simplistic model of sensory integration is actually valid. Nevertheless, I do not think it is unreasonable to advocate the experimentation of both types of practice in order to develop one's multisensory awareness skills and one's ability to listen to sound as acutely as possible – both essential skills to have when on stage.

Secondly, a pianist may choose to influence the audience's perception of sound quality by visual means. Even if the objective sound quality cannot be altered by touch differences, the findings of this paper suggest that the impression of the sound quality can. Gestures convey meaning to the observer and when the gesture is related to the sound being made, it can alter the observer’s perception of it. Gestures can be used in many ways and although some may criticise their inclusion in a discussion about quality-tone production, they find their most relevant application here. Certainly one should use gestures judiciously, for overuse risks putting your audience offside should they feel that the visual display is incompatible or disproportionate to the aural sense. Perhaps not surprisingly, pianists often use exaggerated gesture when the instrument itself is incapable of producing a certain desired sound, for example in communicating single note accents, tenutos or crescendos to the audience.

A common example of this is when trying to produce a *cantabile* sound. The piano tone, by its very nature, peaks immediately in dynamic when struck before decaying rapidly in volume thereafter – it is a percussive sound. Such a sonic decay is in conflict with the idea of a singing sound, which is, ideally, broad, sustained and without accent. In an attempt to convince the listener (or oneself) of a singing sound, it is not uncommon to see the pianist reflect their musical ideals in a physical way. This may be done consciously or unconsciously. For example, the act of trying to press slowly into the keys most certainly reflects the pianist’s intention to reduce or ‘smoothen’ the blow of the piano’s percussive accent. The frequently observed ‘circular’ movement of the forearm and elbow, or ‘rolling forward and upward’ with the wrist during loud chordal playing, are most certainly other examples of the pianist’s desire to smoothen the accent, in this case by trying to buffer the mismatch between the musical intention (unaccented and long) with the sound (accented and short). We recall that these acts are almost universal in piano playing despite the fact that they do not alter the sound quality. Their practical applications are still relevant, however, and are probably explained by their combined function of providing strong proprioceptive feedback (matching physical movement with sound intention), and providing visually ‘coherent’ information to the listener (matching visual gesture with sound intention).

Such proprioceptive-musical-visual coherence is also demonstrated by pianists during *cantabile* playing in the act of staying ‘down in the key’ after its initial key descent. This, it would seem, is done in order to give the impression of a sustained sound (despite its sonic decay). Staying down in the key can take the form of pressing into the keybed (e.g. Levinskaya), simply resting on the keybed without intentional pressure (e.g. Berman), or some degree in between. Sometimes pianists are seen trying to 'draw' the sound out of the key using a slow upward pulling motion so as to provide the illusion of note length (or even crescendo). It has not been examined whether such motions are learned or intuitive but they certainly reflect the pianist's attempt to make the gestural image correspond to the musical image.

From a visual perspective, we know such motions can be influential on one's perception of sound quality. Another example of how musical meaning and, indirectly, sound quality may be conveyed via the visual pathway is the pianist's use of the wrist. It is a common practice to have the hand and wrist rise vertically between phrases to simulate the singer's 'taking a breath'. This was considered to be of such importance to Chopin that he systematically endorsed it, writing 'The wrist: respiration in the voice' (as cited in Eigeldinger, 1986, p. 45). Independent of its musical-gestural importance, it is possibly one of the strongest aids to conveying meaning to the listener, giving a visual description of the singing human voice at the piano; temporarily raised when 'inhaling' between musical phrase. Sokolov's live performance of Chopin's *Mazurka* (Op. 63, No. 3) exemplifies this paradigm.[55] His performance, so compelling in its transmission of expression via the visual pathway, makes a case for the deliberate incorporation of (exaggerated) gestural movements in one's routine practice.

Unfortunately, however, there is a fine line between performance-enhancing gestures and performance-distracting gestures – something which only personal taste may determine. As suggested, gestures may detract from the listening experience when they are too visually distracting or ostensibly fabricated – consider, for example, Lang Lang's controversial performance of Debussy's *Les Collines d'Anacapri*.[56] Excessive gestures, though musically well intended, may also reach a point whereby they interfere with the biomechanical efficiency of playing and effect one's facility or control of sound. This leads us to the important point that the visual gesture alone

[55] See https://www.youtube.com/watch?v=EG8wX5cgKmQ
[56] See https://www.youtube.com/watch?v=7B6iiFqL2sY

should not be considered a substitute for proper sound organisation and tonal control, and should probably only be considered, if at all, in moderation when sound quality and control are already at their maximum – such being the case in Sokolov's performances, for example.

C. Non-biased Teaching

The findings from this study also have implications for teachers. In the same way that pianists may become confused by the many conflicting opinions regarding tone production, teachers themselves should be careful not to add to the confusion. This study suggests that claims made by authors should be rigorously evaluated, giving careful consideration to the context in which the claims are made and also the evidence for them. Teachers, ideally, should know the reasons behind their tone-touch belief system before imparting them onto students. They ought to be aware of their own prejudices and bias. To indiscriminately teach a student to adopt a specific biomechanical approach because it worked for them (or worked for their teacher) is imprecise and misleading; it side-steps the question of tone quality causality and provides no further guidance or understanding to the student for whom it has failed to achieve results.

Drawing on the finding that the definition of tonal quality only becomes relevant within a given musical context, a teacher should encourage the student to seek results within that context. There is no evidence that differences in posture and biomechanics directly alter the sound quality. Consequently, ways of improving sound quality should not be sought there. Ultimately, it is the ability to perfectly realise a perfect mental image of sound that determines one's sound quality. This necessitates sound planning (which is based on musicianship and imagination) and concentrated listening skills (the ability to discern discrepancies between the ideal sound image and the actual sound being produced). Evidence would suggest that developing these two skills offers a more direct pathway towards sound control rather than finger exercises *per se*. Such a conclusion is not new to pedagogy, but does substantiate the value of such a learning strategy.

Accordingly, the role of the teacher in teaching biomechanics can be kept to a bare minimum. As the objective sound quality is the same regardless of the biomechanical pathway, a teacher need only direct the students towards the known principles of motion (laws of inertia and momentum) and guide their techniques towards that which economises effort and facilitates the necessary dexterity. As suggested in earlier chapters, biomechanical inefficiency might be excused when it results in a more elevated musical performance and where no compromise to long-term performance ability is identified (e.g. using biomechanics that may lead to injury).

The idea that one's perception of sound quality is influenced by non-mechanical elements may also be utilised by the teacher. Taking a holistic view, it would seem that extending the tone-touch paradigm to include the domains of tactile touch, proprioception, gesture and vision (pertaining to the observer) are as important to the cultivation of one's touch as are the objective biomechanics themselves. A teacher may wish to encourage the student to explore these relationships with an open mind and find ways to help them interrelate their technique with their musical intentions in a natural way. The act of communicating through sound and gesture has primitive, neurological origins and these should be both nurtured and enjoyed on stage as in the practice room.

Some degree of caution must remain, however, for to enjoy the gesture too much may preclude biomechanical efficiency or technical accuracy. In the event that a pianist's biomechanics become grossly distorted, tense or inefficient, the teacher (and the student) might have to focus specifically on rectifying the faults at the expense of a temporary loss of overall performance level. Ideally, however, the two need not be mutually exclusive. Certainly, in the performance of technically difficult music, it may only be possible to achieve the sound goal following a very lengthy period of time dedicated to technical improvements and biomechanical optimisation. Notwithstanding, a pianist must always have an ideal sound image in mind prior to performance, regardless of its technical difficulty. It might be considered a goal of good teaching that both musical performance and biomechanical optimisation may be nurtured simultaneously and optimally.

Finally, teachers, in their role as informed experts of piano technique, should appreciate the importance of their role in providing evidence-based information to their students. This study has shown that traditional opinions on matters of tone production cannot be trusted – this is evidenced by the diversity of opinion and the lack of scientific evidence for the claims being made. Teachers must not only accept the relative nature of piano tone quality but also the relative nature of piano pedagogic traditions. A fine comb needs to be used to extract the truths about tone production given the biases of their different background contexts. To simply propagate the information of one or more parochial traditions does not constitute sound teaching. In my opinion, a teacher should feel a sense of duty towards understanding the pedagogical literature and explaining to the student the *how* of tone production and the elements that do and do not contribute to its quality. They should encourage and facilitate reflective practice. Furthermore, in one's judgement of sound quality, the teacher must be aware of the non-sonic influences (especially visual) on sound perception. This has implication in judging sound in the teaching studio as much as it does as a jury member of an international piano competition.

3. My singing tone – a practical example

The following section examines the way in which these general conclusions may be applied to personal practice. A narrative (in the first person) details the author's approach to the task of sound quality optimisation both in preparation and performance. A recital, performed in 2012, serves as the basis for the discussion. Special consideration is given to the practical issues related to the optimisation of tone quality, and specifically the communication of the 'singing' tone. For this reason a detailed account of the performance of Chopin's Prelude in F sharp major (Op. 28, No. 13) will be given. (This Prelude can be found at 55'16" during Recital No. 1 on the DVD attached.)

The recital took place in a large hall, seating almost 700 people (with some 200 in attendance). The acoustic was very resonant. The instrument was a top of the range Shigeru Kawai concert grand piano. The recital had two halves of which the Chopin

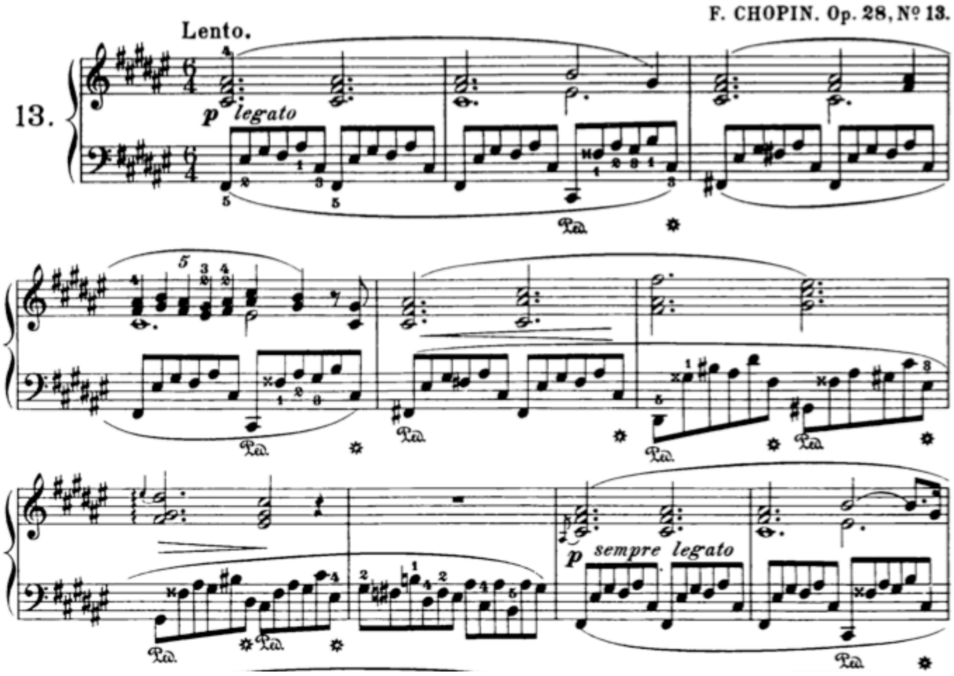
Préludes featured in the second half as the most important work of the program. The F sharp major Prelude is the prelude in the middle of the set of 24 (number 13). It is unique in terms of its tonality (F sharp major – the furthest from the opening key of C major), and also its deep expression. It is marked *Lento* and a melody in the soprano voice dominates a gentle textural accompaniment throughout. As an interpreter, my goal was to project to the audience the deep intimacy of the movement, its languid melodic voice and its luxurious texture.

Firstly, months prior to the performance, I contacted the concert organisers to ask about the nature of the hall, the instrument and the acoustic. I was also given details of the nature of the event (the opening recital of a piano festival). I personally made contact with a pianist who had performed in the hall and also found photos of the performance venue via the internet. Such information helped me to understand the sonic and visual parameters in which I was going to operate. Given the large space and wet (very resonant) acoustic I could plan several things; (i) large gestures both musically and visually would be required; (ii) extra effort would need to be made to keep the musical layers separated, either by distinction in volume or texture; and (iii) sustaining the *cantabile* sound or maintaining the homogeneous texture of the left hand would not be a particular challenge.

Knowing such information beforehand also helped to minimise the potential shock of arriving at the venue on the concert date and needing to adjust to its new parameters. To adjust requires time and, in the case of lack of time, can leave one fighting to come to terms with the instrument and the acoustic during the performance itself. Such a distraction affects one's concentration and, in turn, affects one's success in realising performance goals.

I was also told that a piano technician would be available to me for a short time prior to the concert. Though he did not have the time to regulate the entire action, I made specific requests to him to equalise the sound quality of several notes (which were either too 'bright' or 'dull' sounding), the mechanical resistance of some keys, and to enhance the repetition speed of several notes in the upper registers of the instrument (to help in the performance of Listz's *Mephisto Waltz No. 1* in the first half).

Regarding sound organisation the following actions were taken. Firstly, the soprano voice was deliberately played louder than the other voices. This meant not only playing it louder than the left hand accompaniment but louder than the other voices in the right hand (which are invariably played together as chords throughout the piece; see, for example, **Excerpt no. 1**, bars 1-7).



Excerpt no. 1. Chopin: Prelude Op. 28, No. 13, bars 1-10.

(Schirmer/Mikuli edition, 1943, p. 20)

This way of giving distinction to the melodic line is in no way original to piano playing – it is the standard method of creating the illusion of the singing voice. The illusion is probably due to the fact that it helps the listener to distinguish between melody and accompaniment and also because a note that is played louder will sustain for longer (relative to the others) and hence give the impression of note length. Naturally, the sustaining pedal was used in order to give additional warmth to the left hand accompaniment texture. Such practice can also be seen in Ravel's *Oiseaux tristes*, which requires that the melody is distinguished against at least two distinctive textural layers throughout. See **Excerpt no. 2**, bars 3-6.

Excerpt no. 2. Ravel: *Oiseaux tristes*, bars 1-7.

(Dover edition, 1986, p. 49)

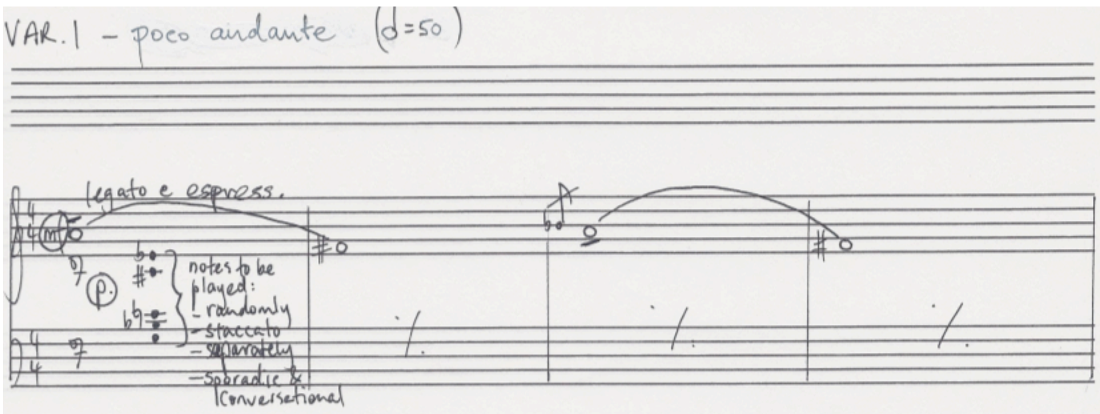
Importantly, changes in the pedal were made slowly to avoid abrupt verticalisation of the sound (i.e. to avoid the musical 'accent' of having the sound texture broken when the sustain pedal is released). Such a pedal technique adds to the illusion of length in the right hand's melody. See, for example, in the Chopin Prelude in F sharp major, the points of harmonic change between bars 2 and 3, or in the middle of bar 7 (**Excerpt no. 1**).

The above technique of separating melody from accompaniment and using slow pedal changes to avoid the verticalisation of sound were used universally throughout the recital. Another example of such usage was during the first movement of Beethoven's Sonata Op. 27, No. 2 where the textural effect asked for my Beethoven ('*senza sordini'*) is one of blurred harmonies (see the opening bars of this sonata for example, **Excerpt no. 3**).

Excerpt no. 3. Beethoven: Sonata Op. 27, No. 2, bars 1-7.

(Peters edition, 1910, p. 248)

For other reasons, occasionally the pedal was deliberately not used in order to enhance the textural difference between the long melody note and the shorter accompaniment notes (see for example Variation no. 1 of Robert's *Sad Bird Blues* – **Excerpt no. 4**). Given the very wet acoustic, I was not concerned about releasing the sustained pedal more than I might have had the acoustic been dry.



Excerpt no. 4. Roberts: *Sad Bird Blues*, Variation no. 1, bars 1-4.

(Original manuscript, 2008)

The illusion of the singing soprano voice was also enhanced by other means. At all times the dynamic given to each melodic note of a phrase was such that it followed the curve of the phrase a singer might produce, building up towards a point of musical tension, and then falling during its release. The same illusion is further intensified by the use of *rubato*. This, paradoxically, becomes a special function of the left hand accompaniment in its ability to push the phrase forwards and backwards to match the natural ebb and flow of the singer's breath speed or overall emotional-musical intention. Examples of both these techniques can be seen within the first two phrases of Chopin's Prelude (bars 1-2 and bars 3-4) and the extended third phrase (bars 5-8) – see **Excerpt no. 1**.

So far, concepts of sound organisation have been discussed. The specific matter of the tone-touch relationship is now considered. Personally, I am not convinced that the manner of touching the key affects the tone quality. Nor do I believe that the nature of the key descent correlates in any way to the tonal outcome, but for its correlation to hammer velocity. Nevertheless, I do give great consideration to the way in which key contact is made. For example, in this Prelude I enjoy having the fleshy pad of my finger in full contact with the key surface whenever a singing sound is required and whenever it is biomechanically comfortable to do so. In the middle section (bars 21-28) of the piece I emphasise this further, firstly as it is easier here (no inner voices to play in the right hand), but secondly because the music is more emotionally deep. See **Excerpt no. 5**.

Excerpt no. 5. Chopin: Prelude Op. 28, No. 13, bars 21-29.

(Schirmer/Mikuli edition, 1943, p. 21)

I enjoy letting myself become absorbed into the sound, both inwardly and outwardly, by the sensory contact – it helps to focus my listening. I note too that on playing longer notes, or more emphatic ones, my arm weight remains for longer on the keybed. I do this, not because I believe that it makes the sound deeper or richer, but because it feels both musically and gesturally right to do so.

As a consequence of playing on the flesh of the finger, rather than the tips, I have noted that my wrist tends to become lower. As we have found, this does not affect sound quality, and as it requires no special effort nor affects the biomechanics of playing to any practical extent, the temporary lower wrist position is of no consequence whatsoever. Similar occurrences of this practice can be noticed during other works in the same recital, for example during the *espressivo amoroso* middle section of Liszt's *Mephisto Waltz No. 1* (see **Excerpt no. 6**).

Excerpt no. 6. Liszt: *Mephisto Waltz No. 1*, bars 371-389.

(Peters edition, 1913, p. 79)

Body posture and movements were also carefully considered. Despite my belief that they have no bearing on the objective sound quality, I believe that they can be used to influence the audience’s perception of sound quality. In this performance, I deliberately considered ways in which my physical movements could enhance the projection of the expressive goals that I had set. One such goal was to highlight the central importance of the F sharp major Prelude, its intimacy and its languid voice. To begin with, a brief pause (of several seconds) was taken before commencing the movement. Conscious effort was made to be physically still. This served to frame the musical canvas in silence – acoustically as well as visually – and indicate to the audience that that which was to follow was ‘of more importance’.

Immediately prior to the commencement of the first phrase, my right hand rose naturally above the keyboard before falling onto it. This physical gesture felt musically appropriate, but also served the function of giving a visual impression of ‘breathing in’ before singing. I believe it also helps to visually delineate the right hand (melody) from the left hand (accompaniment) for the audience. The speed of the gesture and the speed of the key attack were intentionally slow. Although this, in my opinion, was unlikely to change the sound quality, it was to visually communicate the mood of *lento* and ‘calm’. Throughout the movement, the trunk of the body remained very still for similar reasons, firstly, to enhance the overall impression of stillness, but more importantly to draw the audience into a listening experience rather than a visual one. This contrasts distinctly with the more varied postures used during the third movement of Beethoven's Sonata Op. 27, No. 2, Liszt's *Mephisto Waltz No. 1* and Roberts' *Sad Bird Blues*, all of which have many rapid, agitated, character changes.

Melody notes, once struck, were either held down gently with a motionless hand (to give the visual impression of 'still being sung') or, in the event that I wanted to give the impression of a tenuto or a crescendo, with a hand that drew itself gradually upwards as the note was held (to simulate drawing the sound 'out' of the instrument – see, for example, **Excerpt no. 1**, bars 6-7). Such techniques have been previously described in the literature. In this case, the movements were usually intuitive but some were also consciously planned. At all times the body, the hands and fingers were kept in a state of comfort. This was to allow ease of movement but also to promote the (synaesthetic) fusion of the various physical senses (tactile, proprioceptive, auditory, visual).

The impression of singing is also conveyed by keeping the melody note depressed by the finger even when it is held by the sustaining pedal. No tonal difference can result from holding it down (as the damper is already held off the string by the pedal) but the visual portrayal of legato is potentially disturbed if the finger should 'abandon' its note by moving off it or towards the next one before the full length of the one being played is satisfied. The benefit of such a technique may reasonably be questioned, however, as the benefit on sound quality is via visual means, not acoustic. Nevertheless, I believe the tactile connection of the finger with the key obliges the pianist to be more psychologically committed to the melody. A very famous example of such practice is seen in the first movement of Beethoven's Sonata Op. 27, No. 2 in the right hand where the *legato* of top voice (commencing bar 5) is 'enhanced' by holding the key down with the finger despite it already being held by the fully depressed pedal. See **Excerpt no. 3**.

The superimposition of sound waves (of other notes) onto the note being played has not been studied in this research, nor has the effect of the sustain pedal on sound quality been examined. Given the lack of evidence to suggest that the isolated tone can be manipulated by touch, it is reasonable to believe that many of the objective (and subjective) differences in sound quality can be attributed to these tonal 'blends' and the techniques pianists use to achieve them. An obvious example of where such a technique is used is in the opening bar of Ravel's *Oiseaux tristes* (see **Excerpt no. 2**). Here, an isolated tone is played with staccato touch with full sustain pedal. It has not been studied whether the *staccato* touch transmits itself into the observable acoustic spectrum when the sustain pedal is used – thus it remains possible that the *staccato* touch is entirely redundant (acoustically speaking). The findings of this study would, nevertheless, support its application for two reasons.

Firstly, a musically appropriate gestural display of *staccato* may convey musical meaning to the audience (via the visual domain) and to the performer (via proprioception) independent of its objective acoustic profile. Secondly, different touch forms transmit their vibrations differently from the key surface, the keybed and through the instrument's structure into the string. Theoretically, if the string should already be freely vibrating (as in the case of using the sustain pedal), it would capture some of these frequencies, which would result in a different tone quality. Interestingly, the same explanation could be used to argue that even in the absence of the sustain pedal, so long as some strings (of other notes) are available to vibrate freely (e.g. held down by fingers of the opposite hand) when a *staccato* note is played, the vibrations within the instrument's structure caused by the *staccato* touch could potentially be captured by those strings. This hypothesis, if proven, would justify the use of different touch forms in piano playing scenarios where more than one note is being played at a time – that is, almost always.

A final application of how knowledge of the tone-touch relationship might be applied to piano playing is in the performance of very loud notes or accented notes. Using an example taken from my second recital, Rachmaninoff's Prelude Op. 3, No. 2 (see **Excerpt no. 7**), where the utmost sound (***fff***, *pesante*) and tonal accent (***sffff***) is demanded of the performer, several technical-acoustic issues arise.

Excerpt no. 7. Rachmaninoff: Prelude Op. 3, No. 2, bars 46-48.

(Boosey & Hawkes edition, 1985, p. 6)

Firstly, as large volumes require fast hammer speeds, fast key depression must be occurring. As it is impossible to generate such fast key speeds simply by pressing the key from the surface, a degree of 'drop' (with its resultant surface noise) onto the key surface is inevitable and should not be technically avoided or denied.

Secondly, in attempting to differentiate between 'very loud', 'very accented' and 'harsh', the pianist may wish to exploit the potential of the thump component of tone production. Using the same example, two factors may be considered. The keybed thump will be mostly unnoticeable in the lower registers (because the low frequency thump will be masked by the low frequency tones) and so the pianist will need to work harder (more finger-key contact noise and more keybed noise) to achieve any percussive accent to the sound. Conversely, in the higher register, the thump will be more readily audible and achieved. Unfortunately, although the thump component may contribute to the desired accent, it may also contribute to an undesired harshness of tone quality. The distinction is fine at such large volumes and often difficult to judge from the stage. There is, however, in my opinion (based on the data of Kinoshita et al. (2007)), a potential opportunity for pianists to reduce the contributions of the softer thump components without altering the overall tonal volume. This may be effected by some degree of reduced key surface noise or reduced keybed follow-through, and it could provide a physical pathway for the acoustic differentiation of accented and non-accented notes for notes of the same volume. It is interesting to note that when this point was raised during my lecture-demonstrations, there tended to be near universal agreement amongst pianists that this was indeed the case.

Concluding remark

At the end of this study into the practical and pedagogical aspects of the tone-touch relationship, I stand much better informed as to the possibilities and limitations of defining, producing and conveying different tone qualities to the audience. I cannot say definitively if my personal approach to tone production is optimal or successful, but I can be more confident in knowing that all the tone-touch variables have been explored. I cannot be sure, either, if the visual impact of the performance influenced the audience's perception of sound quality, but, as there is evidence to suggest that it does, and that my physical movements coincide naturally with both gesture and musical goals, I see no reason why the potential impact of the visual element should not be considered in a live-performing context.

The findings of this study, which derive from a critical review of performance-based and scientific opinion (literature review), discussion with fellow students and teachers (lecture-demonstrations), and personal reflective practice (recital preparation and performance) lead me to believe that the physical actuality of touch serves two goals: firstly, the goal of tonal manipulation (be it real or imagined) and, secondly, the goal of musical communication via gesture, both to the pianist and the audience. Personally, exploring the limits of touch helps me (the performer) to engage more with the musical creation, to get 'inside' the sound, and, possibly, to help audiences engage more with it also.

In the examples used, we see that decisions made in regards to the organization of the sound are always derived from the process of musical interpretation. This points out an underlying principle: that touch forms are derived from one's musical intention, not necessarily one's ability to alter sound quality. We might expect, therefore, that there will be as many approaches to tone production as there are personalities that give them purpose – and this does appear to be the case. On a basic level, the tone-touch relationship appears to remain explained by simple, physical laws. From a perceptual point of view, however, the tone-touch relationship ought to be considered as a more complex tone-touch *experience*. Accordingly, there still remains a mystery for pianists (and listeners) to explore. As Samuil Feinberg hints, 'the notion of illusion is bound up with the very principle of piano sound' (as cited in Barnes, 2008, p. 15).

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Appendices

Appendix A – YouTube citations

Chapter 1

Performer	Work	YouTube link
Glenn Gould	Scriabin – *Desir*	http://www.youtube.com/watch?v=JllD47HIees
Daniel Barenboim	Chopin – Nocturne Op. 27, No. 2	http://www.youtube.com/watch?v=eoBB_a61jyk
Vladimir Horowitz	Rachmaninoff – Piano Concerto No. 3	http://www.youtube.com/watch?v=lusMu2LGIUM
Vladimir Ashkenazy	Chopin – Prelude Op. 28, No. 24	http://www.youtube.com/watch?v=-FoABv3IhDg
Benno Moiseiwitsch	Rachmaninoff – Prelude, Op. 32, No. 10	http://www.youtube.com/watch?v=fjlltDlJSQQ&list= PLOAdj6bh1lf5d9pYw2xU8UxyuY-4xxeCi
Mikhail Pletnev	Chopin – Preludes Nos. 2 & 4, Op. 28	http://www.youtube.com/watch?v=poWrXii8baI
Arthur Rubinstein	Chopin – Etudes Op. 10 & Op. 25	http://www.youtube.com/watch?v=dFUlvEilmJo
Sviotoslav Richter	Recital:Beethoven, Schumann, Rachmaninoff etc.	http://www.youtube.com/watch?v=jX3ekL7AIxw
Daniel Barenboim	Chopin – Piano Concerto No. 1	http://www.youtube.com/watch?v=FkbQrFru2Co
Lang Lang	Debussy – *La fille aux cheveux de lin*	http://www.youtube.com/watch?v=jGSZPRk6aXA
Loius Kentner	Liszt – Gnomenreigen	http://www.youtube.com/watch?v=wPtbimvqBrQ&feature=youtu.be
George Cziffra	Liszt – Polonaise No. 2	http://www.youtube.com/watch?v=kpAifNIK-4Q
Glenn Gould	J.S.Bach – Goldberg Variations	http://www.youtube.com/watch?v=N2YMSt3yfko
Vladimir Horowitz	Rachmaninoff – Sonata No. 2, Op. 36	http://www.youtube.com/watch?v=-JaY0IZEy90

Chapter 2

Performer	**Work**	**YouTube link**
Grigory Sokolov	Chopin – *Mazurka* Op. 63, No. 3	https://www.youtube.com/watch?v=EG8wX5cgKmQ
Lang Lang	Debussy – *Les Collines d'Anacapri*	https://www.youtube.com/watch?v=7B6iiFqL2sY

Appendix B – Program of Recital No. 1

Winthrop Hall, Perth, Australia, 12th April, 2012

Program

Beethoven – Sonata, Op. 27, No. 2

Ravel – *Oiseaux tristes* (from *Miroirs*)

C. Roberts – *Sad Bird Blues* (2008)

Liszt – *Mephisto Waltz No. 1*

Chopin – *Préludes*, Op. 28

Program Notes

Beethoven (1770-1827) wrote his famous 'Moonlight' Sonata in 1801, one year before his attempted suicide and during a time of great personal and artistic struggle. Its two dark outer movements in the minor key are contrasted by a more conventional central movement in the major, as Liszt described it: 'the rose between two chasms'. The work is famous for its formal originality and its sustained and restless emotion. Of note, the title 'Moonlight' is entirely erroneous, and was given by a German music critic five years after Beethoven's death, after comparing the first movement to moonlight shining on a lake. Actually, the movement is a musical lament for the dead with brass-like funeral-march rhythms set against gentle guitar-like accompaniment figures typically found in Eighteenth-century Italian opera.

Ravel (1875-1937) *Oiseaux tristes* (Sad birds) is one of five pieces from the piano suite *Miroirs,* first performed in 1906. Ravel writes: "The earliest of these pieces - and, it seems to me, the most characteristic - is *Oiseaux tristes…* In this work, I evoke birds lost in the torpor of a very dark forest during the hottest hours of summertime". Ravel uses three different bird calls (a Blackbird, a cuckoo, and another unspecified). Each has its distinctive harmonic and rhythmic accent and Ravel sculpts them into a magical time-space dimension to great hypnotic effect. The many sound layers (Ravel states: birds high up, forest murmurs down low), rich pedal and constant lack of harmonic resolution add to the spaciousness of the musical canvas, one of the very finest in French impressionism.

C. Roberts (b.1977) composed Sad Bird Blues in 2008 for the Australian pianist Ashley Hribar. The work is an homage to Messiaen (in the 100th year of his birth) and combines elements of bird song, a great inspiration to him, and also other characteristic compositional techniques of his. The work has eight movements (*Introduction*, 7 *Variations*), and each follows the standard Blues pattern. There are three bird-song motives in the work, each presented in the *Introduction* and later developed. That with the 'falling minor third' represents the 'sad bird' and is as much a reference to Ravel as to Messiaen. The rich harmonic language of Messiaen is given tribute also in choosing to use the octatonic scale throughout. Short moments of improvisation are also called for, as in *Variation I* (providing the conversation of the birds) and in *Variation VII*, where the performer is asked to quote bird-songs from Messiaen's own works.

Liszt (1811-1886) The "Mephisto Waltz No.1 - The Dance in the Village Inn", composed between 1859-1862, is one of Liszt's most popular works for piano. The composer puts to music the poet Lenau's version of *Faust*: there is a wedding feast in progress in the village inn, with music and dancing; Mephistopheles and Faust decide to enter whereupon Mephistopheles snatches a fiddle and draws from it indescribably seductive and intoxicating strains; the dancers give themselves over to love as does the amorous Faust who falls for the village beauty in a wild dance; they waltz in mad abandon out of the room, into the open, away into the woods where the nightingale warbles his love-laden song.

Chopin (1810-1849) writes: "I am happy on the outside, especially among my own folk; but inside something gnaws at me; some presentiment, anxiety, dreams - or sleeplessness - melancholy, indifference - desire for life, and the next instant, desire for death; some kind of sweet peace, some kind of numbness, absent-mindedness". This unsettled state of mind finds its expression in Chopin's *Preludes,* written between 1835 and 1839 and completed in Mallorca when he was suffering terribly from his tuberculosis. Notwithstanding, the work is inspired in every way, and offers us the quintessential Chopin, fathoming the mysteries of the soul with beauty and refinement at every turn.

The *Preludes* is a singular work divided into a degustation menu of twenty-four finely wrought miniatures, each with their own distinctive flavour. There are *Mazurkas*, *Nocturnes*, *Etudes*, and a great number of *Impromptus* which often serve as complete works in themselves or merely passing fragments. They are organized harmonically in major-minor pairs and proceed through the entire cycle-of-fifths. In this respect there is an obvious reference to J.S.Bach's 24 Preludes and Fugues, a much-adored volume by Chopin. The Fugues are, however, here left out, leaving just the Preludes, which is to say that each Prelude serves as a prelude to yet another Prelude. This is formally ingenious, leading the listener ever onward, though working perhaps more powerfully as a Romantic metaphor for 'desires repeatedly unfulfilled'.

Notwithstanding Chopin's love of classical aesthetics, (restraint, simplicity, good taste etc.) the *Preludes* is an archetypal Romantic work. There is a deep personal involvement on behalf of the composer and he does not hide it. One finds despair, desolation, the *Wanderer*, the *Weltschmerz*, and extremes of emotions typical of such states. But there is also a longing for and idealisation of beauty. Chopin, our 'poet of the piano' finds his natural voice in this ambience and indulges in it.

If the *Preludes* are so special for one singular reason, I would point to their portrayal of mystery as their defining mark - a mystery of the mind and a mystery of the senses. Each Prelude is meticulous in detail, yet elusive in meaning. In my opinion Chopin plays with our senses in such a way to induce a type of sensual hypnosis - like the shadows in a Rembrandt or the blurred-edge *sfumato* technique of a Da Vinci. The music is 'real' and 'unreal' both at the same time. It obscures night with day and light with shadow. One becomes 'lost'. This important side of Chopin's art was well-recognized by his listeners: "like a clairvoyant, lost in his dream... he abandoned himself with such concentration that all extraneous thoughts simply fell away... bewitching us all with its unfathomable mystery... one feels as though suspended somewhere between heaven and earth"; and, in the words of Chopin himself, "I indicate - it's up to the listener to complete the picture".

- Program notes by Cameron Roberts, 2012

Appendix C – Program of Recital No. 2

Elder Hall, Adelaide, Australia, 30th July, 2014.

Program

Rachmaninoff – The 24 Preludes

Prelude, Op. 3 No. 2 [1893]
C sharp minor – Lento

Ten Preludes, Op. 23 [1903]

No. 1 – F sharp minor - *Largo*

No. 2 – B flat major - *Maestoso*

No. 3 – D minor - *Tempo di minuetto*

No. 4 – D major - *Andante cantabile*

No. 5 – G minor - *Alla marcia*

No. 6 – E flat major - *Andante*

No. 7 – C minor - *Allegro*

No. 8 – A flat major - *Allegro vivace*

No. 9 – E flat minor - *Presto*

No. 10 – G flat major – *Largo*

Thirteen Preludes, Op. 32 [1910]

No. 1 – C major - *Allegro vivace*

No. 2 – B flat minor - *Allegretto*

No. 3 – E major - *Allegro vivace*

No. 4 – E minor - *Allegro con brio*

No. 5 – G major - *Moderato*

No. 6 – F minor - *Allegro Appassionato*

No. 7 – F major - *Moderato*

No. 8 – A minor - *Vivo*

No. 9 – A major - *Allegro moderato*

No. 10 – B minor - *Lento*

No. 11 – B major - *Allegretto*

No. 12 – G sharp minor - *Allegro*

No. 13 – D flat major - *Grave*

Program Notes

In 1892, at the age of 19, Rachmaninoff graduated from the Moscow Conservatoire. He had already developed his extraordinary gifts as a pianist, had found his own voice as a composer, and with the acclaim of his idol Tchaikovsky, was awarded the coveted Gold Medal upon graduation. His Prelude in C sharp minor, op. 3 no. 2, published in 1893, brought him immediate fame throughout Europe and America. Following years of depression and inactivity, following the failure of his Symphony No. 1 (1897), he reemerged in 1900 composing some of his finest and best-loved works which include the Piano Concerto No. 2 (1901), his Cello Sonata (1902) and the set of 10 Preludes for piano (1903). Although it was not Rachmaninoff's original intention to compose a set of twenty-four preludes, the 13 Preludes, Op. 32 (1910), complete the set and provide a prelude for each key of the scale. These later works are more complex pianistically, harmonically and emotionally, and often appear to have underlying programmatic and literary references. Rachmaninoff's compositional style has often suffered criticism for being old-fashioned, but he himself declared that he never made any effort to be original and that he could not understand modern music. He wrote his music 'from the heart' and its generous lyricism, sumptuous harmonies and virtuosic piano writing brings the dying composer-pianist Romantic tradition far into the 20th century.

- Program notes by Cameron Roberts, 2014