Proceedings of
ISPS 2007

Proceedings of the International Symposium on Performance Science 2007

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AEC, PO Box 805, NL-3500 AV Utrecht, The Netherlands

Published worldwide in The Netherlands by the
Association Européenne des Conservatoires, Académies de Musique et Musikhochschulen (AEC)

The AEC is a European network of institutions in higher music education
www.aecinfo.org

First published 2007

ISBN 978-90-9022484-8

Typeset and printed by Designarte (www.designarte.pt)
in Portugal

Preface

Performance is a multifaceted pursuit, and as such, the study and investigation of performance has become increasingly interdisciplinary in recent years. The International Symposium on Performance Science aims to bring together artists and scientists, researchers and practitioners, and students and teachers for a lively exchange on performance and the skills which underpin it.

The first ISPS, held in Porto's Casa da Música on 22-23 November 2007, focused on theories, methods, and applications of performance science within the field of music. Musical performance, even at its most elementary levels, requires the management of a wide array of cognitive, motor, perceptual, and social skills. Together, these enable instrumental and vocal control, interpretive insight, and close coordination and synchrony with fellow performers. These skills, moreover, are influenced by the physical strains of practicing and performing, as well as the demands that arise from performing in different venues and in front of different audiences. It seems clear, therefore, that there is tremendous scope for furthering insight into music making by engaging in interdisciplinary discourse and debate; given the diverse nature of musical performance, it also seems clear that the fruits of such discourse will offer far reaching implications for fields beyond music.

For ISPS 2007, researchers and practitioners at every level were invited to submit papers on work exploring the interface between skilled artistry and scientific discovery. The result is a collection of articles that showcase recent initiatives which have employed scientific theories and methods to inform the art of performance and used performance as an exemplary means of advancing theories and applications of science. These proceedings, which reflect the chronology of the symposium, represent a broad range of applications and interests from across the field of music, as well as the natural, social, and applied sciences.

We hope that this volume will spark further discussion within and beyond music and, importantly, give rise to subsequent collaborative investigations. We believe that it is through an interdisciplinary approach that research will contribute most significantly to the understanding of performance and to assist performers in their primary role: performing.

Acknowledgments

There are many organizations and individuals whose support and sponsorship have made ISPS 2007 possible. First and foremost, we would like to acknowledge the generous backing of our two institutions, the Research Centre for Science and Technology in Art (CITAR) at the Portuguese Catholic University, Porto, and the Centre for Performance Science (CPS) at the Royal College of Music, London. We are delighted to acknowledge the generous support of Casa da Música in providing a world class facility in which to host the first ISPS; colleagues there have made every step of organizing this conference truly enjoyable. We are also deeply indebted to the European Association of Conservatoires (AEC) and the European Society for the Cognitive Sciences of Music (ESCOM) for sponsoring the event and to the Portuguese Foundation for Science and Technology (FCT) for support in producing these proceedings. The designers and editors at Designarte have given unreservedly of their time and ingenuity in putting this book together, and we would also like to thank Terry Clark from the Royal College of Music for his diligence, thoroughness, and resourcefulness in editing and revising the proceedings manuscript. Finally, we wish to acknowledge the many researchers and practitioners who have contributed their valuable work to both the conference and to this volume.

Aaron Williamon
Daniela Coimbra

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Thursday
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Keynote paper

International Symposium on Performance Science
ISBN 978-90-9022484-8

From the Neanderthal to the concert hall: Development of sensory motor skills and brain plasticity in music performance

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For thousands of years, humans have striven to express and communicate their feelings by singing and playing musical instruments. In order to create new sounds, instruments were invented requiring novel and frequently complex movement patterns. Sensory-motor skills of musicians have some specific qualities: learning begins at an early age in a playful atmosphere. Routines for stereotyped movements are rehearsed for extended periods of time with gradually increasing degrees of complexity. Via auditory feedback, the motor performance is extremely controllable by both performer and audience. These specific circumstances seem to play an important role for plastic adaptations of the central nervous system. Training-induced changes include both brain function and brain structure and can be observed in sensory-motor and auditory networks. However, in the last two centuries increasing specialization and, as a consequence, prolonged training have produced dysfunctional adaptations of the brain, leading to secondary deterioration of movement patterns referred to as musicians' dystonia. This disorder could mark the final point of human evolution of sensory motor skills.

Keywords: brain plasticity; expertise; sensory-motor integration; focal dystonia; evolution

For thousands of years, it has been through the hands of musicians mastering their instruments that humans have communicated and manipulated their emotions. In modern times, we are fascinated by the precise execution of very fast, and in many instances, extremely complex movement patterns, characterizing the skills of professional musicians when performing as virtuosos. When did this faculty develop though? Can musicologists provide an answer to questions concerning the evolution of motor skills by analyzing the degree of difficulty required in musical scores? Are there innate limitations of the central nervous system with respect to the mastery of fast and complex movements? Is there evidence of a shift in human motor accomplishments in historical times? Or, looking at the problem from another perspective, if a time machine had enough space for a Steinway Grand Piano and an expert piano teacher, could an inhabitant of ancient Egypt, given that he is properly instructed during childhood and adolescence, learn to perform the Liszt *B-minor Piano Sonata*?

Sensory-motor skills of musicians in historical times

Definite conclusions about manual skills of musicians cannot be made until the advent of musical notation and preserved witnesses about the quality of the execution of music supplied by contemporaries. In Baroque times, outstanding musicians and performers like Johann Sebastian Bach or Domenico Scarlatti composed extremely demanding music, which in some aspects reach the limits of technical feasibility even for highly specialised virtuoso performers of today. When taking Bach's *Goldberg Variations* as an example, its execution demands exceptional technical skills in some aspects; the rapidity of trills and passages or the precision of bimanual co-ordination for example. However, later performing composers like Liszt—who was an excellent interpreter of Bach's piano music—used these technical refinements as a basis and added further technical difficulties, such as a novel leap and repetition technique to realize his musical visions. In an informative article, Lehmann (2006) convincingly demonstrates the increasing demands on manual skills in musicians over the past three centuries. According to this author, the technical challenges are paralleled by the developments of musical instruments, which in turn in many instances were initiated by outstanding performing composers. An example is the extension of range (number of notes) of the piano. In the eighteenth century alone, the tonal range of the piano grew from four to six octaves. Beethoven requested larger tonal ranges from his piano maker. The same was true for Liszt, who finally arrived at the "modern" range of eight octaves in the nineteenth century. A similar extension is documented for other instruments, such as the recorder, the violin, and the flute. Additionally, innovations in playing techniques of performing composers added complexity to required manual skills. The "third hand" technique for example, developed by the pianist Siegismund Thalberg in the 1830's involves distributing the melody notes between the hands in the middle of the keyboard, while the accompaniment is played in scales and patterns to the left and right side of the melody. This technique destroys not only the classical mapping of hands onto the keyboard with the right hand playing the melody while the left provides the accompaniment, but additionally requires maintenance of dynamic differences between the melody and the accompaniment within one hand, this way imposing heavy skill requirements on the performer (Lehmann 2006).

The increasing refinement of musicians' manual skills during the last three centuries is well documented. However, the question remains whether this improvement is due to early specialization and longer cumulative practice times or whether other factors such as the instructional strategies may have had a crucial impact on the acquisition of manual dexterity. When analyzing the technical skills of child prodigies performing keyboard music in public from the times of Bach until the twentieth century, Lehmann (2006) comes to the conclusion that during this time span acceleration in the acquisition of performance skills took place. In other words, there is a significant tendency for prodigies of more recent generations to play technically more difficult pieces after shorter periods of training than did earlier prodigies. Several factors contribute to this effect. Firstly, over the centuries there is a tendency toward earlier commencement of musical training. Not uncommonly, outstanding contemporary performers start their systematic training at ages younger than six years. Secondly, accumulated procedural knowledge of the most effective teaching methods handed down from generation to generation of performer/teachers may have resulted in an optimization of training methods. Thirdly, due to the specialization of young performers, who focus on only one instrument and neglect other activities, there is increased time spent preparing for performances. Anecdotal evidence for the latter notion is abundant from the nineteenth century on. The pianists Clementi and Czerny are said to have practiced eight hours per day already as children in "solitary confinement" at the piano, Kalkbrenner for 12 hours and Henselt even for 16 hours (Lehmann 2006).

In summary, it is indisputable that the demands on manual skill for the reproduction of composed "serious" music increased continuously from Baroque times until the middle of the twentieth century. It is not only the complexity of movement patterns, but also the elements of tempo, strength, stamina, and the precision of hand and finger movements which constitute this process of increasing perfection over the centuries. Modern society in turn imposes heightened pressures on performers of composed music by comparing the individual live performance in concert with recordings of outstanding peers, easily available on CDs. Additionally, with the possibility of obtaining and splicing multiple takes, studio recordings contribute to an illusionary perfection as standard. All of these changes are reflected in the intensification and prolongation of daily practice. However, one should keep in mind that this development holds only for a relatively small group of musicians, namely the highly specialized classical musicians in the Western cultures of reproducing classical music. The majority of musicians all over the world are either amateur players, playing their instruments in various social contexts, or professionals relying more on improvisational skills (in jazz music, for instance) or on the technical developments of instruments and electronic equipment (for example in rock and pop music).

Brain adaptations accompanying behavioural pressures

Music, as a sensory stimulus, is highly complex and structured along several dimensions. Moreover, making music requires the integration of multimodal sensory and motor information and precise monitoring of the motor performance via auditory feedback (Walsh *et al.* 2007; Figure 1).

In the context of western classical music, musicians are forced to reproduce highly controlled movements almost perfectly and with high reliability. These specialized sensory-motor skills require extensive training periods over many years, starting in early infancy and passing through stages

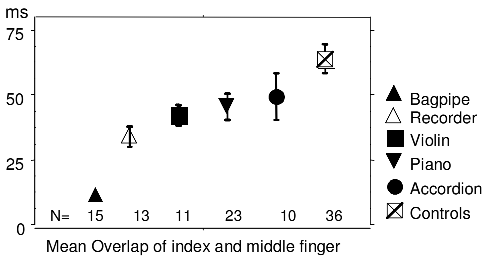

Figure 1. Behavioural adaptations: The role of auditory feedback in a sensory-motor transfer task. Overall averages of a test of synchrony in different groups of professional musicians. The task was to avoid any overlap while touching a metal pad with one index finger and synchronously releasing another finger in a series of trill-like movements which were executed in a standardized and metronome-paced tempo. The pipers clearly have the smallest amount of undesired overlap, followed by woodwind players. The results demonstrate that motor control in musicians is specifically guided by auditory feedback since avoiding overlap is critical in any pipes and woodwind instruments, but not in keyboards and the accordion (bars=±1 SEM; from Walsh *et al.* 2007).

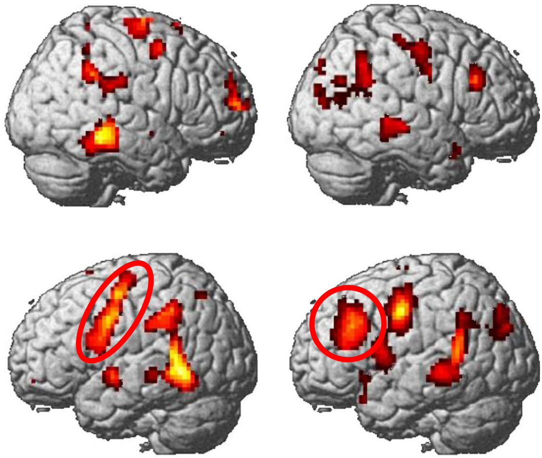

Figure 2. Central nervous adaptations: Auditory-sensory-motor co-representation in a group of seven professional pianists investigated with functional MRI compared to a group of seven non-musicians. The colored spots indicate increase in brain activation in pianists compared to the non-pianists. In the upper row, the right hemisphere is displayed, and in the lower, the left hemisphere. Listening to simple piano tunes (left side) in professional pianists activates the sensory motor areas, especially over the left hemisphere (red circle on the left). Playing simple piano tunes on a silent keyboard activates the left frontal lobe areas (red circle on the right), which are related to gesturing and language processing (modified from Bangert *et al.* 2006, with permission). (See full color version at www.performancescience.org.)

of increasing physical and strategic complexities.

The superior skills of musicians are mirrored in plastic adaptations of the brain on different time scales. At one extreme, years of musical experience, especially in those musicians who begin training early in life, might lead to an increase in grey and white matter volume in several brain regions, including sensory-motor and auditory areas, the cerebellum, and the anterior portion of the corpus callosum. These anatomical alterations appear to be confined to a critical period. The fact that in several of the studies a correlation was found between the extent of the anatomical differences and the age at which the musical training commenced strongly argues against the possibility that these differences are pre-existing and the cause for, rather than the result of, practicing music. At the other extreme, several minutes of training can induce changes in the recruitment of auditory or motor cortex areas, or establish auditory-sensory-motor coupling (Bangert and Altenmüller 2003; Figure 2).

Musician's Dystonia: The final point of a development?

There is a dark side to the increasing specialization and prolonged training of musicians, namely loss of control and degradation of skilled hand movements, a disorder referred to as musician's cramp or focal dystonia (Figure 3). The first historical record, from 1830, appears in the diaries of the ambitious pianist and composer Robert Schumann. As was probably the case for Schumann, prolonged practice and pain syndromes due to overuse can precipitate dystonia, which is developed by about 1% of professional musicians and in many cases ends their career (Jabusch and Altenmüller 2006). Neuroimaging studies point to dysfunctional (or maladaptive) neuroplasticity as one of the relevant pathomechanisms.

Support for this theory comes from a functional brain imaging study performed on musicians with focal dystonia. Compared to healthy musicians, the patients showed a fusion of the digital representations in the somatosensory cortex, reflected in the decreased distance between the representation of the index finger and the little finger when compared to healthy control musicians (Figure 4). Such a fusion and blurring of receptive fields of the digits may well result in a loss of control, since skilled motor actions are necessarily bound to intact somatosensory feedback input.

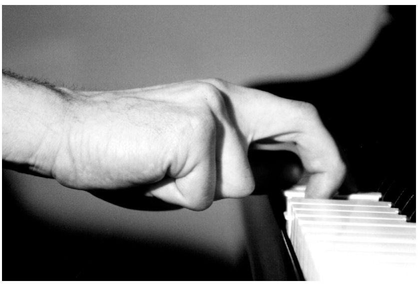

Figure 3. Symptoms of dysfunctional plasticity: Focal dystonia in a pianist. Involuntary flexion of the middle, fourth, and fifth fingers while attempting to play a C-major scale with the right hand. Typically in dystonia, no pain or sensory symptoms are reported. Dystonia may afflict almost all groups of instrumentalists but is more frequently seen in the right hand of guitarists and pianists and in the left hand of violinists (Altenmüller 2003).

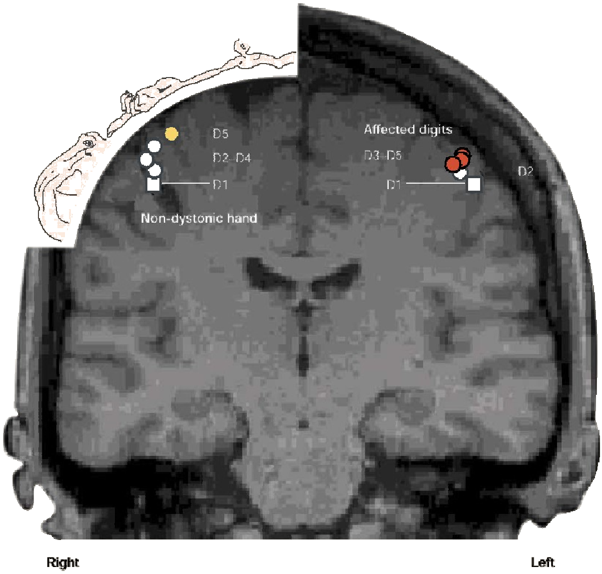

Figure 4. Neuronal correlates of dysfunctional plasticity. Fusion of the somatosensory representation of single digits of the hand in a musician suffering from focal dystonia. The best fitting dipoles explaining the evoked magnetic fields following sensory stimulation of single fingers are shown projected on the individual's MRI. Whereas for the non-affected hand, the typical homuncular organization (see inset) reveals a distance of about 2.5 cm between the sources for the thumb and the little finger (white square and brown circle on the left), the somatosensory representations of the fingers on the dystonic side are blurred, resulting from a fusion of the neural networks which process incoming sensory stimuli from different fingers (red circles). (Modified from Elbert *et al.* 1998 and Münte *et al.* 2002). (See full color version at www.performance-science.org.)

Considering (a) the historical advent of the disorder in the nineteenth century with rapidly increasing technical demands imposed on musicians, (b) the epidemiological data with rapid and repetitive finger movements as a risk factor, and (c) the above mentioned neurobiological findings of the blurring of hand representations, one is tempted to state that focal dystonia finally marks the natural limits of a process of refinement of manual dexterity over a million years. However, according to a very recent study hereditary factors with a certain predisposition to develop this condition may also play a role (Schmidt *et al.* 2006).

From Neanderthal to Carnegie … and future developments?

Finally, we have to answer the questions raised in the first paragraph. The time machine with the expert piano teacher from a renown German music academy arrives with the Steinway D Grand Piano 3500 years ago in the valley of the river Nil. I have no doubt that the young son of the Pharao, if started at age four with our German professor, could have learned to play the Liszt *Sonata*, given that he was endowed with enough passionate motivation for the approximately 10000 hours of training required, given that he had access to a protein-rich diet to develop large bones, robust muscles, and hands flexible enough to span the tenths.

According to paleo-neurological findings, the brain's structure has not changed significantly in the last 100 000 years. It is highly probable then that humans of the upper Paleolithic period—around 30 000 years B.C.—were able to execute demanding movement patterns when playing on their bone flutes. The true "revolution" which enabled *Homo sapiens* to master novel tasks occurred much earlier in human evolution. It was enabled by the development of *neural plasticity*, the potential to adapt to new environmental stimulation and to new challenges by modification of neural networks, and this potential was most likely present long before the first musical instruments were developed.

As has been demonstrated in the preceding paragraphs, the musicians' brain is an excellent paradigm to study the short- and long-term effects of central nervous neural plasticity and long term adaptation in sensorimotor systems, even in macroscopical brain structures. Furthermore, in the case of focal dystonia, neuroscientists have become aware of the limits of these adaptations under certain stressful conditions.

It is beyond any doubt that creative innovations will continue to be made, but as far as manual skill of the independent use of the fingers is concerned, it seems that a final point in a million-year long development was reached somewhere between the beginning and the middle of the twentieth century. For the piano, the works of late romantic performing composers such as Rachmaninoff, Godowski, Albeniz, and Alcan, with their extension of the Lisztean technique, mark an end point for the age of virtuosos. When comparing the available recordings, contemporary performers do not seem to be essentially superior to the previous generation.

The new challenge in performing compositions of the "classical" modern composers, for example of Messiaen, Boulez, Ligeti, which are all extremely difficult to master, is not based on new demands of manual skill, but rather in their complex musical structure and novelty of rhythmic and harmonic patterns. Since these patterns are as yet usually not integrated in the systematic training of music students, they seem extremely demanding; however, they do not present a new qualitative or quantitative challenge in respect to manual dexterity. Many contemporary composers try to overcome the natural limitations of hand skills by exploiting unusual ways of producing sound, such as plucking the strings in the piano or using the open holes for glissandi in the flute. These new techniques challenge manual dexterity in a new way, but they do not add new complexity to the independent use of fingers as was, for example, the case with Thalberg's third hand technique. Another aspect is important concerning future developments: a majority of music enthusiasts feel uncomfortable when exposed to contemporary music and many of them feel unable to judge the quality of the performance. As a consequence they may have difficulties in perceiving outstanding perfection and will not reward extraordinary manual skills as was the case in earlier times. In other words, society will cease to offer appropriate incentives for performers to study these pieces for months or even years.

After all, I suggest that manual dexterity has reached the end of adaptation—at least in the conventional style of music making. The advent of disorders such as musicians' cramp may well be a warning sign of biological limitations in individuals, who are especially susceptible to disturbances in neural plasticity. It is not only pathology or the maximal available accumulative time of optimal training which limits the "artistic" aspect of musical performance however, it is the fact that society wants to feel *the need to communicate behind the fingers*, the original personal expression of emotional experience. The latter, of course, has to be collected somewhere outside the practice room, limiting the time assigned for manual exercises in a natural way.

Acknowledgments

I am grateful to Hans-Christian Jabusch and Marc Bangert for their most significant contributions to the experimental data reported in this article and for comments on an earlier version of the paper. This work was supported by a grant of the DFG (SPP 1001, Al 269/1-3).

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References

Altenmüller E. (2003). Focal dystonia: Advances in brain imaging and understanding of fine motor control in musicians. *Hand Clinics, 19,* pp. 1-16.

Bangert M. and Altenmüller E. (2003). Mapping perception to action in piano practice: A longitudinal DC-EEG-study. *BMC Neuroscience, 4*, pp. 26-36.

Bangert M., Peschel T., Rotte M., *et al.* (2006). Shared networks for auditory and motor processing in professional pianists: Evidence from fMRI conjunction. *Neuroimage, 15,* pp. 917-926.

Elbert T., Candia V., Altenmüller E., *et al.* (1998). Alteration of digital representations in somatosensory cortex in focal hand dystonia. *NeuroReport, 16,* pp. 3571-3575.

Jabusch H. C. and Altenmüller E. (2006). Epidemiology, phenomenology and therapy of musician's cramp**.** In E. Altenmüller, M. Wiesendanger, and J. Kesselring (eds.), *Music, Motor Control, and the Brain* (pp 265-282). Oxford: Oxford University Press.

Lehmann A. C. (2006). Historical increases in expert music performance skills: Optimizing instruments, playing techniques, and training**.** In: E. Altenmüller, M. Wiesendanger, and J. Kesselring (eds.), *Music, Motor Control, and the Brain* (pp 3-22). Oxford: Oxford University Press.

Münte T. F., Altenmüller E., and Jäncke L. (2002). The musician's brain as a model of neuroplasticity. *Nature Reviews Neuroscience, 3,* pp. 473-478.

Schmid A., Jabusch H. C., Altenmüller E., *et al.* (2006). Dominantly transmitted focal dystonia in families of patients with musician's cramp. *Neurology, 67,* pp. 691-693.

Walsh G., Jabusch H.C., and Altenmüller E. (2007). Synchronization of contrary finger movements in pipers, woodwind players, violinists, pianists, accordionists and non-Musicians. *Acta Acoustica*, in revision.

Poster session

International Symposium on Performance Science
ISBN 978-90-9022484-8

Excellence in achievement contexts: Psychological science applications and future directions

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The study of human excellence has always been present in the development of psychological science, although its theory, research, and practice focus have been mainly on negative and pathological issues. Many authors have attempted to explain and understand youth and adults' exceptional achievements in several achievement domains, such as science, art, or sports. Here, we consider three main different approaches that study excellence. There are those which focus on natural talent, those which propose intensive training and practice as main factors of high and outstanding performances, and those which define excellence in the context of wisdom. Analyzing the current literature, we can distinguish training, deliberate practice, and exceptional performance specificity resulting from a precocious involvement and commitment to a specific domain as main points of convergence. Cognitive, motivational, affective, and personality characteristics, as well as contextual elements such as learning experiences and supportive environments, are emphasized as crucial factors in the developmental process of excellence. This concern and interest in human excellence appears to be shared by professionals from different domains. New challenges for future research in this field are presented.

Keywords: excellence; giftedness; expertise; wisdom; performance

The modern world calls for adaptable, flexible, and expert professionals able to succeed in challenging, changing, and complex work contexts. In this scenario, social and human sciences reinforce the interest in the study of exceptional individuals and their profiles, looking for potential common patterns of human excellence. The history of psychology makes us aware that concern with human potential, strengths, wellbeing, and quality of life have always been core aims of psychological research and practice, despite typically being focused toward disease, disability, and pathology (Seligman and Csikszentmihaly 2000). Works like Galton's (1869) *Hereditary Genius* and Terman's longitudinal studies of giftedness in the 1920s have become milestones in the study of exceptionality, explaining outstanding performance through hereditary factors or relating it to high cognitive abilities. In the early 1950s, in connection with the humanistic movement, new conceptions of intelligence and a growing interest in creativity contributed to enhancements in the investigation of high abilities, expertise, and talents (see Pereira 2000) while exploring other personal and contextual factors in the conceptualization of excellence. Illustrative and classic studies that influenced the excellence research field include Roe's pioneering work with eminent scientists in the 1950s, Chase and Simon's work with elite chess players and their resulting theory of expertise in the 1970s, and Bloom's study with artists, scientists, and athletes in the 1980s. The emergence of the positive psychology movement in the 1990s placed a new focus on human strengths and challenged the current *status quo* of psychological research, emphasizing personality, cognitive, and affective qualities as indicators of excellence, success, wisdom, and happiness (Seligman and Csikszentmihaly 2000).

Despite the research in this field having started with Galton's work a century ago, it remains incipient. The concept of excellence is far from being clearly defined, in spite of its common and general usage by people (Trost 2000). A continuum of theoretical trends and methodological options has led to the application of a variety of criteria in attempts to identify and define excellent individuals, while different concepts have been used to describe outstanding achievement. In the present work, three main themes guiding research in this field are identified: giftedness, expertise, and wisdom. Using different perspectives and conceptions of competence, talent, or skill, all the approaches focus on the study of the quality of being superior or exceptional. A summary of the major approaches in the study of excellence as well as their main features and contributions is presented here. Finally, potential implications to research in the field of performing arts are discussed.

MAIN CONTRIBUTION

The psychological study of excellence developed from different departing perspectives. The nature-nurture debate is one of the most controversial subjects among social scientists and has nourished many discussions concerning the origins and development of talent (see Howe *et al.* 1998, Ericsson *et al.* 2007), reflecting the different factors emphasized by a variety of approaches. Different disciplines and fields are now exploring the same main question: "What makes an excellent individual?"

The search for talent predictors and factors through intelligence and aptitude measures, pointed out by giftedness research, was clearly influenced by the psychometric tradition. Even nowadays, the IQ factor remains an important criterion of intellectual and academic giftedness (see Robinson and Clinkenbeard 1998, Almeida *et al.* 2000). The emergence of multi-dimensional intelligence theories brought motivational and creative features to the giftedness definition, recognizing talent in specific domains. Renzulli (2002) defends the Three Rings Conception, suggesting that a gifted behavior has three components: above-average ability (general ability and/or specific ability), high levels of task-commitment, and high levels of creativity. Gagné (2004) conceptualizes talent as the demonstration of a systematically developed ability through learning and practice, which places the individual among the top 10% of peers having similar training. Finally, Sternberg (2001) defines giftedness as developing expertise, suggesting that mastery on one or more performance domains is the result of a continuous process of acquisition and consolidation of specific competences.

This last perspective is close to those arguing for the critical role of deliberate and continued practice in attaining expert performance, as defended by Ericsson and colleagues (see Ericsson and Charness 1994). In another achievement context, sport psychologists have developed a growing work in the field of expertise, inspiring research studies with performing artists such as dancers, musicians, and actors (see Sloboda 2000, Kogan 2002, Ureña 2004). Historically centered mainly on performance excellence, a focus on personal excellence with additional concerns about emotions, quality of life, and wellbeing of elite and top performers became a growing and more recent trend in psychological research (Miller and Kerr 2002).

In addition, a similar concern with personal excellence is clear in more recent research on wisdom, with the leading efforts of Baltes, Sternberg, Ardelt, and their research teams. Generally, wisdom is associated with maturity (not directly to elder people), and requires a unique integration of a multitude of cognitive, affective, and personality characteristics (Ardelt 2004). Wisdom is defined as "expert-level knowledge and judgment in the fundamental pragmatics of life" (Staudinger *et al.* 1998, p. 2), covering broad aspects of excellence in virtue and mind with "common good" and wellbeing as major goals (Sternberg 2004). Another related perspective is suggested by Moon (2003), who defined personal talent as an "exceptional ability to select and attain difficult life goals that fit one's interests, abilities, values, and contexts" (p. 5).

It seems that excellence approaches are spread along a continuum from those which take innate abilities into account to those which defend a more holistic way to cope with life problems. Though, some critical issues are also shared. Many studies have sought to distinguish among intelligence, personality, and learning experiences and contexts the most important factor to predict excellence, but the results are inconsistent (see Robinson and Clinkenbeard 1998, Staundinger *et. al.* 1998, Trost 2000). Taken together, in general, there is some agreement on the important role of motivation and personality characteristics (e.g. persistence, time on task, strong commitment), superior cognitive abilities (e.g. metacognitive abilities, reasoning, planning), and significant experiences and contexts as dominant factors for excellence development, identification, and prediction (see Lubinski and Benbow 2000 and Gould *et al.* 2002). The role of extensive experience and deliberate practice in the acquisition of task mastery and specialized knowledge in one activity or domain is commonly emphasized (Ericsson *et al.* 1993, Staudinger *et. al.* 1998, Lubinski *et al.* 2001, Sternberg 2001, Hays 2002). Precocious contact and practice with activities of a particular domain and subsequent enrichment learning experiences seem to put the individual on the road to excellence (see Ericsson *et al.* 1993, Rossum 2001, Moore *et al.* 2003). Finally, supportive and challenging contexts are highlighted, in particular the role of family, teachers (or coaches), and peers in order to sustain and regulate persistence, discipline, pushing involvement, positive emotions, high expectations, and focus (see Subotnik and Olszewski-Kubilius 1997, Winner 2000, Gould *et. al.* 2002, Ericsson *et. al.* 2007).

IMPLICATIONS

What seems evident is that different approaches share the same questions about human excellence. If certain domains (e.g. sport psychology) have developed a solid research on this theme, others are just in a promising start. Though psychological research on performing arts is not extensive, many research studies have been conducted, particularly in general and specific topics of musical excellence. However, research within performing arts like dance or visual arts are still embryonic (Hays 2002, Kogan 2002, Ureña 2004). On the other hand, contemporary concerns about elite performers' emotional wellbeing and personal excellence have improved research addressing life skills, mental skills, and emotional regulation skills. More research in this field is needed, including some descriptive studies before refined and comprehensive theoretical conceptualizations. Additionally, multifactorial and longitudinal case studies, as well as cross-domain research in different achievement contexts are welcome for future research advances.

Acknowledgments

The present article was supported by a grant from the Fundação para a Ciência e Tecnologia, Portugal (National Foundation for Science and Technology).

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References

Almeida L., Oliveira E., and Melo A. (2000). *Alunos sobredotados: Contributos para a sua identificação e apoio*. Braga: ANEIS.

Ardelt M. (2004). Wisdom as expert knowledge system: A critical review of a contemporary operationalization of an ancient concept. *Human Development, 47*, pp. 257-285.

Ericsson K. A. and Charness N. (1994). Expert performance: Its structure and acquisition. *American Psychologist, 49*, pp. 725-747.

Ericsson K. A., Krampe R. Th., and Tesch-Römer C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, pp. 363-406.

Ericsson K. A., Roring R., and Nandagopal K. (2007). Giftedness and evidence for reproducibly superior performance: An account based on the expert-performance framework. *High Abilities Studies, 18*, pp. 3-56.

Gagné F. (2004). Transforming gifts into talents: The DMGT as a developmental theory. *High Ability Studies, 15,* pp. 119-147.

Gould D., Dieffenbach K., and Moffett A. (2002). Psychological characteristics and their development in Olympic Champions. *Journal of Applied Sport Psychology, 14,* pp. 172-204.

Hays K. F. (2002). The enhancement of performance excellence among performing artists. *Journal of Applied Sport Psychology, 14,* pp. 299-312.

Howe M. J., Davidson J. W., and Sloboda J. (1998). Innate talents: Reality or myth? *Behavioral and Brain Sciences, 21,* pp. 399-442.

Kogan N. (2002). Careers in the performing arts: A psychological perspective. *Creativity Research Journal, 14*, pp. 1-16.

Lubinsk D., Benbow C. Shea, D., *et al.* (2001). Men and women at promise for scientific excellence: Similarity not dissimilarity. *Psychological Science, 12,* pp. 309-317.

Lubinski D. and Benbow C. (2000). States of excellence. *American Psychologist, 55*, pp. 137-150.

Miller P. S. and Kerr G. (2002). Conceptualizing excellence: Past, present and future. *Journal of Applied Sport Psychology, 14,* 140.153.

Moon S. M. (2003). Personal talent. *High Ability Studies, 14*, pp. 5-21.

Moore D. G., Burland K. B., and Davidson J. (2003). The social context of musical success: A developmental account. *British Journal of Psychology, 94*, pp. 529-549.

Pereira M. (2000). Sobredotação: A pluralidade do conceito. *Sobredotação, 1*, pp. 147-178.

Renzulli, J. (2002). Emerging conceptions of giftedness: Building a bridge to the new century. *Exceptionality, 10*, pp. 67-75.

Robinson A. and Clinkenbeard P. (1998). Giftedness: An exceptionality examined. *Annual Review of Psychology. 49,* pp. 117-139.

Rossum J. (2001). Talented in dance: The Bloom stage model revisited in the personal histories of dance students. *High abilities studies, 12*, pp. 181-197.

Seligman M. and Csikszentmihalyi M. (2000). Positive psychology: An Introduction. *American Psychologist, 55*, pp. 5-14.

Sloboda J. (2000). Individual differences in music performance. *Trends in Cognitive Sciences, 4*, pp. 397-403.

Staudinger U. M., Maciel A. G., Smith J., and Baltes P. (1998). What predicts wisdom-related performance? A first look at personality, intelligence, and facilitative experiential contexts. *European Journal of Personality, 12,* pp. 1-17.

Sternberg R. J. (2001). Giftedness as developing expertise: A theory of the interface between high abilities and achieved excellence. *High Ability Studies, 12*, pp. 159-179.

Sternberg R. J. (2004). Words to the wise about wisdom? A commentary on Ardelt's critique of Baltes. *Human Development, 47*, pp. 286-289.

Trost G. (2000). Prediction of excellence in school, higher education and work. In K. Heller, F. Mönks, R. Sternberg, and R. Subotnik (eds.), *International handbook of Giftedness and Talent (*2nd ed., pp.317-330*)*. Oxford: Pergamon.

Ureña C. (2004). *Skill Acquisition in Ballet Dancers: The Relationship between Deliberate Practice and Expertise*. Unpublished doctoral thesis, Florida State University.

Winner E. (2000). The origins and ends of giftedness. *American Psychologist, 55*, pp. 159-169.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Noise exposure and hearing thresholds among orchestral musicians

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An assessment of noise exposure and hearing thresholds among orchestral musicians was carried out at the Royal College of Music (RCM). Sound exposure data was taken over a one week period using personal noise dosimeters attached to ten RCM orchestra students during rehearsals and during a performance (Rachmaninoff's *Piano Concerto No. 2* and Sibelius's *Symphony No. 2*). Noise levels (and compliance with the UK's noise at work regulations) depended upon the type of instrument being played and where musicians were seated. For example, the average 8-hour A-weighted dosage for the trumpet was $L_{EP,d}$=88.4 dB(A), while it was only 77.1 dB(A) for the double bass. This suggests that different hearing protection strategies may be appropriate for different musicians. Audiogram data taken from 37 students and 19 staff showed that the students (mean age=24.2, SD=4.0) had statistically significant bilateral notches at 6 kHz, indicative of noise-induced hearing loss. Staff members (mean age=45.7, SD=11.0) also had evidence of notches and additionally presented increased thresholds at high frequencies, indicative of expected age-related hearing loss.

Keywords: noise exposure; hearing damage; musical performance; orchestral musicians; music students

Both musicians and non-musicians are susceptible to work-related hearing damage from sound, but unlike other professions, the sound musicians create is not a by-product of their work—it is their product. This distinction makes musicians a difficult special case when it comes to determining what noise regulations should apply to them. Although studies have detailed noise-exposure in the workplace for many professions (e.g. Taylor *et al.* 1965), relatively little is known about the noise dosages musicians receive or the effect this “noise” has on musicians’ hearing (for reviews, see Royster *et al.* 1991; Fearn 1976, 1993; Lee *et al.* 2005).

In this article, we report our measurements of noise dosages and hearing thresholds in young orchestral musicians and compare those data with our measurements of hearing thresholds from older musicians.

METHOD

Participants

Ten student musicians (two violins, viola, cello, double bass, flute, clarinet, trumpet, trombone, tympani) from the RCM Symphony Orchestra were chosen to participate in the sound level recording study (6 female, 4 male; mean age=25, SD=4.0).

Thirty-seven student musicians (25 female, 12 males; mean age=24.2 years, SD=4.0) participated in the audiogram study, along with 19 staff members (11 female, 8 male; mean age=45.7 years, SD=11.0); not all staff members were currently performing musicians.

Procedure

Noise-exposure was measured during one week of full rehearsals and sectional rehearsals leading up to a performance of Rachmaninoff’s *Piano Concerto No. 2* and Sibelius’s *Symphony No. 2*, and the performance itself. Measurements were made using Cirrus CR 110A personal noise dose meters, mounted within 10 cm of one ear of each musician. Average A-weighted sound pressure level (L_{Aeq}) and Peak C-weighted sound pressure level (L_{Cpk}) were recorded each minute during measurement sessions (Figure 1).

Average day, maximum day (8-hour equivalent L_{Aeq}), and weekly noise dosages were calculated from L_{Aeq} dB(A) values obtained each minute. These calculations were made according to the UK Control of Noise at Work Regulations 2005, No. 1643. In addition, each C-weighted peak level (L_{Cpk}) above 120 dB(C) was recorded and plotted.

Audiogram measurements were made with participants comfortably seated in a soundproof room. A recently calibrated (June 2006 and June 2007) Kamplex KC 50 audiometer employing an automated Hughson-Westlake procedure was used. Both normal audiometric frequencies and high frequency thresholds were measured: 125, 250, 500, 1k, 2k, 4k, 6k, 8k, 10k, 12.5k, 16k Hz.

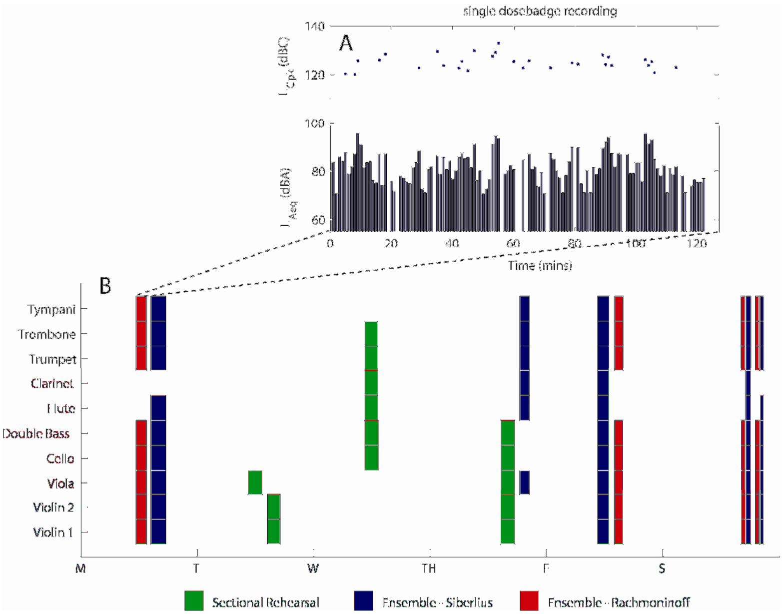

Figure 1. Student orchestral musician workweek chart (panel B) showing the times of rehearsals and performances (Monday to Saturday) during which personal noise level dosimetry was recorded for 10 musicians. Panel A shows one example of dosimetry data collected from the tympani player's dosimeter during a Monday rehearsal. (See full color version at www.performancescience.org.)

RESULTS

Measured maximum personal daily noise exposure levels for seven of the ten musicians registered above 85 dB(A), the specified upper action level in the UK's Control of Noise at Work Regulations 2005 (Figure 2). The exposure levels depended strongly on the instrument being played and where the musician was seated in the orchestra. For example, the cellist registered a maximum daily exposure of 87.9 dB(A), 2.6 dB higher than the maximum day for the trombone player 85.3 dB(A) which was during the same rehearsal; however, during this rehearsal, the cellist was seated in front of the brass section. The trumpet consistently had the highest exposure levels, and always exceeded the upper action level specified by regulations. On the trumpet's maximum day (Monday), he was exposed to the equivalent of eight hours of sound at 90.2 dB(A), well above allowable limits.

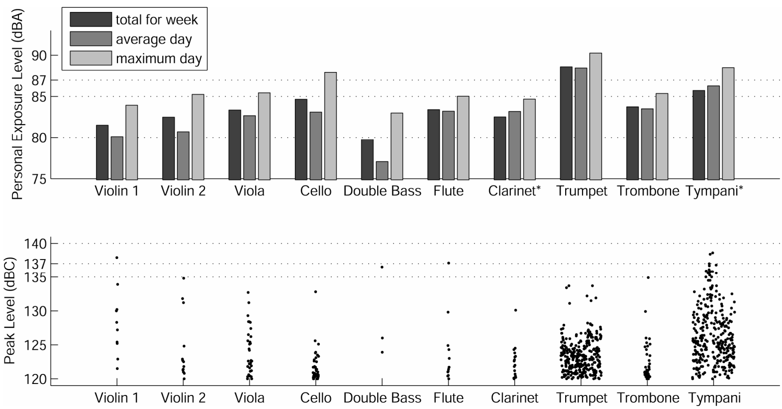

Figure 2. Top panel: Personal daily and weekly dosage levels ($L_{EP,d}$, and $L_{EP,w}$) of 10 student orchestral musicians during one week of rehearsals and performance. Clarinet and tympani data were incomplete (dosimeter failure), so we only have four measurements for their work week (five or six would have resulted in higher weekly levels). The trumpeter received the highest dose, exceeding lower, middle, and upper action levels (dotted lines) of the UK's Control of Noise at Work Regulations 2005 for average day, weekly, and maximum day exposures. Bottom panel: Peak levels greater than 120 dB(C) experienced by players over the course of one week. Percussionists and trumpets appear to be exposed to loud impulsive noise at much greater frequency than other players, and these levels often exceeded lower regulatory action levels and sometimes exceeded middle regulatory action levels.

Measured peak dB(C) levels were generally below 135 dB(C), the lower action level specified in the UK regulations. We suspect that some of the stray impulses recorded were the result of a dosebadge being knocked (e.g. double bass) rather than an actual sound impulse. The timpanist and trumpeter sustained the highest frequency of impulse noises above 120 dB(C) (319 and 305 events, respectively), and the timpanist was exposed to five bursts in excess of 137 dB(C) and three in excess of 140 dB(C) (not plotted).

Audiogram data from the student group showed a statistically significant bilateral threshold notch at 6 kHz, indicative of noise-induced hearing loss. A Wilcoxon signed rank test showed the median threshold at 6 kHz was statistically higher than either the median 4 kHz or 10 kHz threshold. This was true for both left and right ears [$Z(34)=-4.23$, $p<0.001$, and $Z(34)=-3.35$, $p<0.001$, respectively, for left ears; $Z(34)=-4.57$, $p<0.001$, and $Z(34)=-3.93$, $p<0.001$, respectively, for right ears]. Furthermore, paired t-tests indicated

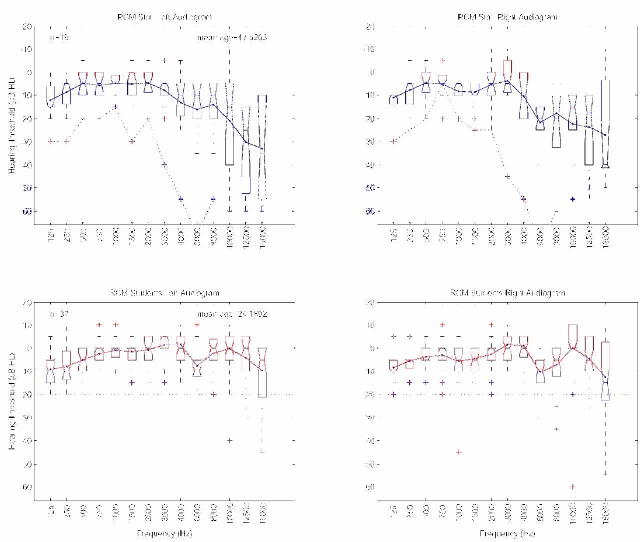

Figure 3. Summary of hearing threshold levels (dB HL) from Audiograms taken from RCM student musicians (bottom panels; mean age=24.2 years, SD=4.0) and staff members (top panels; mean age=45.7 years, SD=11.0). Boxes extend from lower quartile to upper quartile with median hearing level demarked with a red bar, whiskers show extent of the data, and outliers are labeled as red crosses. The mean of the data is plotted as a blue line. The staff members with the highest hearing levels were also the oldest (57, 61, 64 years old); the dotted line shows a 61 year old with the highest thresholds. Bilateral notches at 6 kHz were evident for both students and staff indicative of noise-induced hearing loss. The notch was statistically significant for the student group. (See full color version at www.performancescience.org.)

that the mean threshold at 6 kHz was significantly higher than thresholds at 4 kHz or 10 kHz [all $t(34)>3.96$, $p<0.001$]. Staff data also displayed a bilateral notch, but this was less prominent because staff members also exhibited elevated thresholds at high frequencies, indicative of age-related hearing loss—a loss that tended to blend with and obviate their presumed noise-induced notch at 6 kHz.

DISCUSSION

Noise dosage levels for some musicians (e.g. trumpet, tympani) but not others (e.g. cello) exceeded those specified in UK noise at work regulations that will come into force in April 2008. Our audiogram data suggest that these levels initiate a noise induced hearing loss in young musicians that subsequently contribute (at least in the 6 kHz region) to what would usually be considered "age-related" hearing loss in older musicians. Future research will seek to expand these findings by collecting noise level measurements from a broader range of ensemble types, repertoire, and performance environments. Additional audiograms will be performed with musicians representing the full spectrum of years of involvement; noise data will then be mapped upon these to explore potential links.

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References

Fearn R. W. (1976). Hearing-loss caused by different exposures to amplified pop music. *Journal of Sound and Vibration*, *47*, pp. 454-456.

Fearn R. W. (1993). Hearing loss in musicians. *Journal of Sound and Vibration*, *163*, p. 372.

Lee J., Behar A., Kunov H., and Wong W. (2003). Noise exposure of opera orchestra players, *Canadian Acoustics*, *31*, pp. 78-79

Royster J. D., Royster L. H., and Killion M. C. (1991). Sound exposures and hearing thresholds of symphony orchestra musicians. *Journal of the Acoustical Society of America*, *89*, pp. 2793-2803

Taylor W., Pearson J., Mair A., and Burns W. (1965). Study of noise and hearing in jute weaving. *Journal of the Acoustical Society of America*, *38*, pp. 113-120

International Symposium on Performance Science
ISBN 978-90-9022484-8

Rhythm capacity: Comparison between professional dancers and dance students

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We all have the intuition that different rhythmic factors and different people exhibit different rhythmic behaviors. A sample of professional dancers and university dance students was recruited for this study. Our methodology was based on the application of a specifically built and validated set of questionnaires. This battery of tests was previously applied to young people practicing dance. In the present study, we found no significant differences between the rhythmic factor or synchronization, or between male and female participants. However, when the rhythmic factor involved the reproduction of particular moves, significant differences were found.

Keywords: dance; rhythmic capacity; rhythm factor; rhythm test; structure

Rhythmic behavior in dance is very important. We understand rhythmic behavior as the main point of technical quality and expressive quality (Batalha 2004). In dance, by rhythmic structure we mean the organization of the time and intensity of performance. However, we must stress that the time component is fundamental. While the intensity component is always present marking the structures in a more qualitative manner than the time forms, the time component is of extreme importance for the artistic, expressive, and communicative aspects because it affects the dynamics of emotions, which are reflected in the dance.

In this paper, we present working tools in the area of rhythm and demonstrate that it is possible to quantify rhythmic capacities. Batalha's (1986) battery of rhythm tests has previously been validated, capable of evaluating and analytically studying its components, denominated as rhythmic factors. It can be presumed that different rhythmic factors and different people exhibit different rhythmic behaviors, but few studies have been devised to understand how it is possible to quantify rhythmic motor capacity.

We accept that rhythmic structure is the organization of the temporal and intensity components (Hiriatborde and Fraisse 1968). Analyzing the temporal component is fundamental in motor behavior, but the intensity component may be even more important because it brings out the expressive quality. The intensity structure is essential in the artistic performance, for expression and communication, because it shows the emotional dynamics of the dance.

Improvement in the quality of movement is associated with optimization of the motor representation and with the discrimination of the rhythmic components aroused by the motor activity. Motor development aimed at effective motor control occurs when all the phases are carefully analyzed, with respect to their components and the final product desired.

Whether at the level of motor learning or at the higher level of high performance in dance, there is reference to the mental representation of a movement. This by itself justifies the systematic and detailed analysis of the motor and expressive variables.

Noteworthy is the importance of the mental representation of movement for the following reasons: to facilitate memorization of the actions, to anticipate action (allowing not only the prediction of their effect but also their precise execution), to favor the self-correction of the actions; to promote a good communication, to reach a good performance, to understand the choreography, and to evaluate the message.

The aim of this study was to understand how young professional dancers and university dance students respond to different types of rhythmic stimulus. We compared professional and university-level dancers in terms of rhythm capacity to find differences promoted by the regular practice of dance.

Rhythmic structures (RS)

Historical analysis of motor activities demonstrates that rhythmic structure is an operational constant of motor learning (Batalha 1986, 2001, 2004). Considered as a step in motor development, the quality of movement depends essentially on the contrast in dynamics and timing. Rhythmic intellectualization plays an important role in the learning of routines, given that the rhythmic components are responsible for that quality.

The ideal motor execution, the coherence of motor communication, and aesthetic equilibrium can only be created if a minute analysis of the rhythmic involvement is carried out.

A better understanding of the rhythmic phenomena involves the organization and structuring of the variables inherent in the rhythmic structures (RS), which permit not only self-organization but also the development of purposeful tasks.

Reflecting upon the importance of rhythmic structures in artistic performance, we come to the conclusion of the necessity of discriminating selection of the *temporal* and *intensity dominants* according to their structuring units in order to allow for *superior motor quality* and *efficient communication*, based on mental representation and prior programming.

Dance communication uses message-reinforcement, making use of the intensification of actions, which is the control in this case, to the highest level of sophistication, intensity, and duration of muscular contractions.

For a better understanding of the rhythmic aspects of motor function, and to permit specific forms of intervention in artistic performance, we classify RS according to their components as follows:

- Intensity: when they depend of the accentuation of sharp and soft muscular contractions
- Temporal: according to the duration values of the intervals between the movements and the duration of the contractions as short or long

In both situations, and with respect to motor activity, these structures may be observed and analyzed in:

- Supports: through the quality of weight transfer which is reflected in intensity and temporal aspects
- Body: (center) through the set of muscular degrees of tension which take place within a certain time and with a specific intensity (Thackray 1969).

In summary, rhythmic structure is a group of timing and intensity phenomena**.** The rhythmic structure is essential in performance skills and communicative projects.

General rhythmic motor capacity (GRMC)

These propositions permit not only the understanding of reasons for analyzing rhythmic structures (Fraisse 1956, 1967, 1974), but also the importance of the concept of general rhythmic motor capacity (GRMC; Batalha 1986).

Being unable to formulate a duly tested concept of GRMC, we studied rhythmic factors which correspond to response models and cover both symbolic and motor forms of expression, while integrating the time factor of the moment of response in relation to the stimulus. Our preference fell on motor responses to rhythmic stimuli, considered as expressions of a rhythmic profile characteristic of our area of study: dance.

Rhythmic factors were thus selected in relation to the observable behaviors and the level of processing of the responses, using the research of Fraisse (1956, 1967, 1974) as a point of departure. Thus, we identified general rhythmic motor capacity based on factors whose dimensions are observable behaviors (Le Boulch 1964, Batalha 1986).

Each individual has the capacity to synchronize the rhythmic stimuli of a certain model, either through fine movement or through global movement with footwork or walking. We distinguish three factors of the GRMC:

1. Transcription, which is of a perceptive nature, is based on the discrimination of successive rhythmic structures and its graphic symbolization.
2. Synchronization, corresponding to motor expression synchronized with rhythmic stimulus, is based on previously perceived and memorized rhythms. Stimulus and response are performed simultaneously.
3. Reproduction is a performing situation of motor response complying with the model after the issue of the signal. The performance follows the stimulus.

METHOD

Participants

This study was part of a larger survey and was developed in the region of Lisbon. Being based on Batalha's (1986) battery, a sample of professional dancers from the professional company Ballet Gulbenkian and students from the dance department of the Technical University of Lisbon were recruited. Our methodology was based on the application of a specifically built and validated battery of tests. This allowed us to compare objectively the rhythmic behaviors of two groups (professional dancers and dance students) and two sub-groups (men and women).

The sample was composed of 22 professional dancers between the ages of 18 and 24, and 22 dance students from the university, in the same age range.

Materials

The test used was composed of three parts:

1. Transcription of rhythmic structures (temporal, intensity): perception of three rhythmic sound structures and respective symbolization. Each individual must perceive the rhythmic stimulus, recognize it as a structure, and symbolize it graphically.
2. Synchronization with a rhythmic structure: adjustment of the motor response to the elements of the model. Synchronization is characterized by anticipating the rhythmic adaptation of the responses through the continuous search for synchronization with a rhythmic structure or musical sequence.
3. Reproduction of a rhythmic sound structure and of a movement sequence: perception of a rhythmic structure and execution with hands and feet of the same structure after the rhythmic stimulus; and perception of a sequence composed of four different rhythmic structures for execution through the basic locomotive movements of that sequence after the rhythmic stimulus. This level of response, in the execution of motor performances, calls the memory into operation.

Procedure

The rhythmic stimuli were registered and always performed in the same way. For the application of the tests, we asked each dancer to respond individually in their normal working studio. The tests were always administered by the same researcher.

RESULTS

In this study, we found few differences between professional dancers and dance students, or between male and female participants. Concerning transcription, professional dancers demonstrated slightly higher results, though the difference was not significant. The same was found in synchronization. Regarding reproduction, professionals displayed a significantly higher level of performance.

From this study, we conclude that there are no significant differences between gender, or the two groups, except in the reproduction of particular moves.

DISCUSSION

In conclusion, we understand that regular training in dance develops the capacity for rhythmic reproduction. The lack of studies in this area induces us to some prudence in the possible overall conclusions. We did observe, however, that the professional group was much more apt at reproducing the structures. Given that this capacity entails a large component of memory, it could be said that the practice of dance is a good way of training memory.

We close with the fact that this work demonstrates that it is possible to quantify general rhythmic motor capacity (GRMC) and that the test battery presented is a tool capable of evaluating and analytically studying the component factors, establishing inter-relationships which can help explain individual behavior.

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References

Batalha A. P. (1986). *Análise da Capacidade Rítmica: Construção e Validação de uma Bateria de Testes Aplicada aos Factores Transcrição, Sincronização e Reprodução*. Unpublished doctoral thesis, Technical University of Lisbon.

Batalha A. P. (2001). Analysis of rhythmic ability. Paper presented at the *AIESEP International Congress*, University of Madeira Madeira, Portugal.

Batalha A. P. (2004). *Metodologia do Ensino da Dança*. Lisbon: Faculty of Human Kinetics, Technical University of Lisbon.

Batalla A. P. and Xarez L. (1999). *Sistemática da Dança- Projecto Taxonómico*. Lisbon: Faculty of Human Kinetics, Technical University of Lisbon.

Fraisse P. (1956). *Les Structures Rythmiques*. Paris: Erasme.

Fraisse P. (1967). *Psychologie du Temps*. Paris: PUF.

Fraisse P. (1974). *Psychologie du Rythme*. Paris: PUF.

Hiriatborde E. and Fraisse P. (1968). *Les Aptitudes Rythmiques*. Paris. CNRS.

Le Boulch J. (1964). Organisation du temps et maitrise corporelle, education. *Physique et Sport, 11*, pp. 71-72.

Thackray R. (1969). *An Investigation into Rhythmic Abilities*. London: Novello.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The phenomenology of performance: Exploring musicians' perceptions and experiences

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The present study explored musicians' perceptions and experiences in performance. Specifically, four areas were investigated: (1) the different types of preparation and pre-performance routines in which musicians engage, (2) musicians' thoughts and perceptions of both themselves and their environment while performing, (3) the musical, psychological, and non-musical skills deemed essential for success, including the means by which such skills are acquired, and (4) the types of demands and stressors that musicians face, along with the strategies they employ to manage them. Thirteen student and professional musicians were interviewed. Content analysis was performed using Interpretive Phenomenological Analysis which elicited three general themes: motivation, preparation, and performance experiences. Differences emerged between experienced and less experienced musicians in terms of the breadth and scope of preparation activities for the more experienced musicians. Greater similarities between the participants were found when discussing factors surrounding successful and less successful performances. Successful performances were often connected with feelings of sufficient preparation, positive mindsets, and presented a high yet attainable level of challenge, while less successful performances appeared linked with inadequate preparation, negative mental outlooks, frustration, and lack of enjoyment during the performance itself.

Keywords: motivation; preparation; performance experiences; interpretive phenomenological analysis

Over the last three decades, researchers have studied systematically musicians' practice activities, exploring such topics as the quantity, quality, and content of practice, ways in which musicians structure their learning, and their reasons for engaging in those activities (see Jørgensen 2004). Performances themselves, however, have received somewhat less attention. For example, while Partington (1995) noted that elite musicians employ a variety of clearly constructed pre-performance routines, few studies have actually explored these in any depth. Little is also known about musicians' thoughts and perceptions during performances. In two studies, self-efficacy was found to be a significant and reliable indicator of success in musical performance examinations (McCormick and McPherson 2003, McPherson and McCormick 2006). Research in other performance domains has found that performers' interpretations of their arousal symptoms can have a greater impact on performance outcomes than the actual manifestation of their symptoms (i.e. Hanton *et al.* 2004). Given the apparent relevance of self-beliefs and perceptions to musicians' success, it would appear prudent for researchers to explore musicians' *perceptions* of themselves and their skills, as well as how those perceptions influence practice behaviors and performance experiences.

Given the current state of understanding surrounding the phenomenology of musical performance, this study has sought to investigate the activities musicians engage in when preparing for performance, their thoughts and perceptions during performance, and the impact their evaluation of those thoughts and perceptions has on their subsequent musical activities.

METHOD

Participants

Thirteen musicians were recruited from the Royal College of Music. Of those, six were pianists (three undergraduates, three postgraduates), and seven were vocalists (four undergraduates, three professors). The ages of the participants ranged from 18 to 58 years (mean=29.0, SD=14.3). The students were training in classical music with aspirations of performing professionally and the professors were currently active professional performers.

Materials

A semi-structured interview approach was adopted to allow for an in-depth exploration of the aforementioned issues. In particular, an interview topic guide was created that addressed four main areas: (1) the different types of preparation methods and pre-performance routines in which musicians engage, (2) musicians' thoughts and perceptions of both themselves and their environment present while performing, (3) the musical, psychological, and non-musical skills musicians deem essential for success, including the means by which such skills are acquired, and (4) the types of demands and stressors musicians that face, along with the strategies they employ to manage or cope with them.

Procedure

Prospective interviewees were contacted via email and provided with a brief description of the project. Those wishing to participate in the study replied to the first author, at which point the time and location for an interview were determined. The interviews were recorded digitally and transcribed verbatim. As the goal of this investigation was to establish a contextualized perspective of musicians' subjective experiences with performing, the transcripts were analyzed using Interpretive Phenomenological Analysis (IPA; Smith and Osborn 2003). The analysis procedure involved identifying individual meaning units, or parts of text representing one particular idea, within the transcripts. These units were then grouped with others of similar meaning to form common themes.

RESULTS

From the analysis of the interview transcripts, three general themes emerged: (1) sources of motivation, (2) preparation activities in which musicians engage, including skills and abilities deemed necessary to facilitate successful performances, and (3) experiences during actual performances, including demands and stressors faced in connection with those performances. Although these themes were different from the structure of the interview topic guide, the semi-structured format allowed participants an opportunity to discuss relevant topics of concern to them that may not have previously occurred to the interviewer. For the purposes of this paper, the label "experienced" musician refers to professors (n=3) and postgraduate students (n=3), and "less experienced" refers to undergraduate students (n=7).

Motivation

When asked what attracted the musicians to performance, a number of common factors were identified. Almost all participants (n=6 of 6 experienced, n=5 of 7 less experienced) spoke of a strong love of performing. Other responses included the expressive or communicative aspect of performing (n=4 experienced, n=2 less), the challenge music performance presented (n=2 experienced, n=2 less), as well as the chance to be someone else (n=2 experienced). A variety of personality characteristics also emerged. While many discussed high levels of self-confidence, determination, discipline, and the importance of keeping things in perspective, some of the less experienced musicians (n=3) also spoke of perfectionism and the extremely high self-standards they placed on themselves.

Preparation

Everyone spoke of the need to have music adequately prepared. Most participants reported that their practice activities were modified in the days leading up to a performance, with the focus more on run-throughs and less on technical work. On the day before, the students all cited practice as being of greatest concern. Some singers (n=3 less experienced) planned clothing and costume the night before, which helped them feel more at ease the next day. The more experienced musicians (n=6) all spoke of the need to ensure adequate rest and nutrition, which interestingly none of the students mentioned. On the day of, activities largely revolved around keeping the mind and body active yet still conserving energy. For many of the less experienced musicians (n=5), the aim of these activities was to distract themselves from worrying about the performance. The minutes before the performance were spent trying to stay relaxed and getting into the mood of the music. Some of the less experienced participants (n=4) reported engaging in relaxation exercises such as breathing, yoga, meditation, and prayer. Two students discussed employing elaborate imagery which was used to enhance expressivity, deal with nerves, develop confidence, and solidify memory.

Performance experiences

When discussing potentially contributing factors surrounding what they felt were successful performances, many of the participants (n=3 experienced, n=4 less experienced) explained how they felt adequately prepared and were experiencing high self-efficacy. A number of facilitative views were mentioned, such as a strong emotional connection and love for the music, a positive view of the audience, and general feelings of comfort and familiarity, either with the music, venue, other players, or the audience. The situation was often one presenting a high level of challenge as well (n=3 experienced, n=3 less). These challenges included new types of music, challenging but convincing opera productions, short preparation time, and even battling with injuries or illness. Overwhelmingly, the participants reported feeling relaxed, confident, determined, and happy in the minutes before going on stage. During the actual event, the participants described characteristics of peak performances, such as complete control, trust, and heightened awareness. Focus was also discussed by many of the participants (n=4 experienced, n=6 less). Interestingly, while it could be presumed that a high level of concentration in which nothing non-musical enters the mind is desirable, two participants made a point of saying that they felt irrelevant thoughts would not necessarily hinder their performance.

When discussing what the participants felt were less successful performances, a lack of preparation was cited most often (n=3 experienced, n=7 less experienced). This related to the participants' own preparation of the music, as well as rehearsal with others. Other situational factors also appeared to be linked. A number of the participants talked about being uncomfortable with the demands of the situation (n=2 experienced, n=5 less), such as the music being too difficult or not suited to their voice type, demands placed on them by directors or other performers, high self-pressure, and high perceived expectations from the audience. Many of the participants described a negative mental state and outlook prior to the performance, coupled with low self-efficacy (n=3 experienced, n=4 less). During the performance, participants expressed a pervasive feeling that things could be going better (n=2 experienced, n=4 less experienced). They often felt frustrated and did not enjoy the experience. Some did acknowledge that they felt their thoughts and mood were inhibiting the quality of their performance (n=1 experienced, n=3 less).

DISCUSSION

The impact of accrued experience was well demonstrated, particularly in relation to the participants' preparation activities. The more experienced musicians discussed behaviors that were clearly planned and thought out, and they also possessed a better understanding as to why they engaged in such activities. Greater similarities between the participants were found, however, when discussing factors surrounding successful and less successful performances. Successful performances were often connected with feelings of sufficient preparation, positive mindsets, and presented a high but attainable level of challenge. Less successful performances, on the other hand, appeared linked with inadequate preparation, negative mental outlooks, frustration, and lack of enjoyment during the performance itself. It was interesting to observe such variability in the factors that the participants associated with successful performances though. Given that, the question is raised as to the extent to which such factors actually impact performance quality.

Despite generating a comprehensive body of data that would likely have been unattainable through other approaches, this method was not without concerns and potential limitations. Responses to interview questions are self-report; hence, they are inherently subjective in nature and as such would require further testing in order to be verified. One implication of this is that it is impossible to tell if the participants gave what they felt would be the *right* answers or were actual representations of their behaviors. It is also important to note that when the participants were asked to discuss a successful performance, there was no objective rating as to how *successful* those performances may have actually been. The participants chose a performance they were happy with, which may have been for any number of reasons. Lastly, any causal links that were mentioned were based solely on the participants' perception, not on empirical fact.

The present study has revealed a number of directions for future research. For instance, to what extent is it possible to teach less experienced musicians using the perceptions and understanding of seasoned performers, or must they come to this insight through their own means? The answer to this question (among others) will require further investigation, but the implications of this research promise significant outcomes for music learning, teaching, and performance.

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References

Hanton S., Mellalieu S., and Hall R. (2004). Self-confidence and anxiety interpretation: A qualitative investigation. *Psychology of Sport and Exercise, 5,* pp. 477-495.

Jørgensen H. (2004). Strategies for individual practice. In A. Williamon (ed.), *Musical Excellence* (pp. 85-105). Oxford: Oxford University Press.

McCormick J. and McPherson G. (2003). The role of self-efficacy in a musical performance examination: An exploratory structural equation analysis. *Psychology of Music, 31,* pp. 37-51.

McPherson G. and McCormick J. (2006). Self-efficacy and music performance. *Psychology of Music, 34,* pp. 322-336.

Partington J. (1995). *Making Music*. Ottawa, Canada: Carlton University Press.

Smith J. and Osborn M. (2003). Interpretive phenomenological analysis. In J. Smith (ed.), *Qualitative Psychology: A Practical Guide to Research Methods* (pp. 51-80). London: Sage.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Exploring the experience, expression, and control of anger among singers

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The aim of the present work was to explore the experience, expression, and control of anger of a group of 54 singers at a music college who completed a normative state-trait anger expression inventory (STAXI-2, Spielberger 1999) prior to and after the performances of their mid-year examinations. Both female and male singers differed from their normative groups on the Anger Expression-In scale, which was interpreted in terms of the need to refrain from expressing anger overtly in a competitive and hierarchical system such as that of a music college. In addition, female singers also scored lower in the Anger Control-In scale, which indicates that they experience angry feelings but show a tendency not to develop internal controls to overcome those feelings. The results also showed that there were no significant differences between the singers' State Anger levels prior to and after the performances which indicates that the mid-year examinations did not raise the singers' levels of anger.

Keywords: singers; assessment; emotions; anger; STAXI-2

In the course of the singing activity in a music college, particularly in the context of examinations, there may be several factors that arouse anger. Anger may be a result of the subject's awareness of his/her physical limitations (Lemerise and Dodge 1993). Therefore, it may be hypothesized that given the degree of dependency on the wellbeing of their voice and body, singers might feel angry if their voices do not function well. In addition to this, anger may also stem from the fact that in the moment of the performance, the singer's physical limitations are exposed. Fitness (2000) described five other types of events that made people angry at their workplace, namely (1) being unfairly treated, (2) witnessing amoral behavior, (3) confronting incompetence, particularly one's own, (4) being treated disrespectfully, and (5) being publicly humiliated. Moreover, she found out that anger was expressed more easily toward subordinates than toward colleagues or superiors.

From an interactionist perspective, Berkovitz (1990) suggested that anger stems from a conjunction of three factors: (1) the action being against the subject's will, (2) the subject's expectations being frustrated, and (3) the subject feeling that s/he is not in control of the situation. If one considers that singers devise a performance plan according to which expectations regarding their performances are created, anger may well arise in the course of the singers' activity. Given that most emotions are dependent on the subjects' social context (Averill 1982), it may well be questioned whether, in the singers' social group, the experience of anger occurs more frequently than in other groups and if it occurs for reasons directly related to their activity. In fact, Kemp (1996) suggested that, given the body-orientated modes of functioning of singing performances and their higher sensitivity, singers may operate at a more "feelingful" level than other musicians, and therefore, one may well ask whether singers are more inclined to experience emotions more intensely, namely anger.

A variety of conscious and unconscious processes are used to deal with angry feelings. The three main approaches are: expressing, suppressing, and calming those feelings. According to Spielberger (1999), the amount and the way in which anger is expressed are critical variables. For that reason, a distinction should be made, conceptually and operationally, between the expression of anger, the experience of anger as an emotional state, and the individual differences in anger-proneness as a personality trait. Thus, the aim of this empirical work was to attempt to contribute to the literature by applying a normative state-trait anger expression inventory (STAXI-2; Spielberger 1999) to a group of opera singers.

METHOD

Participants

The participants were 54 undergraduate vocal students (i.e. first-, second-, and third-year students) at the Guildhall School of Music and Drama. In total, there were 29 female singers and 25 male singers. Their ages varied between 18 and 25, with a mean of 21.3 years.

Materials

Participants completed the State and Trait Anger Expression Inventory-2 (STAXI-2, Spielberger 1999). It aims to assess either the intensity of angry feelings at a particular time or how frequently anger is experienced, expressed, suppressed, or controlled by the participants, who, in responding to each of the 57 STAXI-2 items, rate themselves on a 4-point scale. The STAXI-2 consists of six scales: State Anger, Trait Anger, Anger Expression-Out, Anger Expression-In, Anger Control-Out and Anger Control-In, and five sub-scales: Feeling Angry, Feel Like Expressing Anger Verbally, Feel Like Expressing Anger Physically, Angry Temperament, Angry Reaction, and an Anger Expression Index.

Procedure

Two weeks before the school's mid-year examinations, the participants were asked to complete the three parts of the STAXI-2 inventory. Then, during the mid-year examinations, five minutes prior to their performance, the participants were asked to complete Part I of the STAXI-2 inventory. Immediately after the performance, they were asked to repeat the same part, in order to compare the influence of the exam situation/performance on the State Anger of the participants.

RESULTS

The singers' scores were compared with their normative group separately for females and males, in accordance with Spielberger (1999). In order to assess what characteristics female and male singers possessed that might or might not distinguish them from their normative group, a z-test was done. As can be seen in Table 1, significant differences were observed between the mean scores of female singers and their normative group for the scales of Anger Expression-In and Anger Control-In and the Anger Expression Index Scale (Ax Index).

As can be seen in Table 2, the AX-I and Ax Index scores of male singers were significantly different from those of the normative group. Finally, an Analysis of Variance (ANOVA) was carried out in order to compare the State-Anger levels of both female and male singers at three different stages: Stage 1, two weeks before the examination; Stage 2, immediately prior to the examination; and Stage 3, immediately after the examination. The results were *non*-significant. This showed that the State-Anger levels of the singers did not differ at these three stages.

Table 1. Comparison between the mean scores of female singers and their normative group in the STAXI-2 (N=number of observations).

	Female normative group			*Female singers*				
	Mean	*SD*	*N*	*Mean*	*SD*	*N*	*z*	*p*
S-Ang	17.9	4.9	266	18.6	5.4	27	-0.74	0.46
S-Ang/F	6.8	2.3	268	7.0	2.6	27	-0.58	0.56
S-Ang/V	5.9	2.2	269	6.3	2.7	27	-0.93	0.35
S-Ang/P	5.3	1.1	269	5.2	0.5	27	0.44	0.66
T-Ang	18.1	4.9	263	19.4	6.0	27	-1.17	0.24
T-Angt	6.3	2.4	268	7.0	3.0	27	-1.34	0.18
T-Angr	8.8	2.6	267	9.1	2.6	27	-0.77	0.45
AX-O	14.7	3.6	266	15.5	3.7	27	-1.07	0.28
AX-I	15.9	4.4	261	18.0	3.7	27	-2.89	0.00*
AC-O	23.3	5.2	263	23.0	5.6	27	0.18	0.86
AC-I	23.5	6.1	265	21.4	4.8	27	2.11	0.04*
Ax Index	31.7	13.8	248	37.0	13.5	27	-1.97	0.05*

* $p<0.05$

Table 2. Comparison between the mean scores of male singers and their normative group in the STAXI-2 (N=number of observations).

	Female normative group			*Female singers*				
	Mean	*SD*	*N*	*Mean*	*SD*	*N*	*z*	*p*
S-Ang	19.0	6.6	210	18.0	6.8	20	0.57	0.57
S-Ang/F	6.9	2.7	216	6.6	3.5	20	0.37	0.71
S-Ang/V	6.3	2.7	214	5.9	1.6	20	1.00	0.32
S-Ang/P	5.7	2.0	214	5.5	2.0	20	0.43	0.67
T-Ang	18.4	4.8	211	20.5	6.5	20	-1.48	0.14
T-Angt	6.4	2.4	213	7.0	2.6	20	-1.16	0.25
T-Angr	8.8	2.5	214	9.6	3.3	20	-1.19	0.23
AX-O	15.0	3.5	212	16.6	4.6	20	-1.51	0.13
AX-I	16.6	4.0	207	20.2	6.5	20	-2.44	0.02*
AC-O	23.6	4.8	213	22.9	4.7	20	0.64	0.52
AC-I	23.1	5.6	208	21.2	5.6	20	1.37	0.17
Ax Index	32.7	12.3	196	40.0	13.5	20	-2.35	0.02*

* $p<0.05$

DISCUSSION

The singers' trait anger levels were not significantly different from their normative group. In this way, they do not seem to be more inclined than other groups to experience anger more intensely. This was hypothesized after Kemp's (1996) suggestion that given the body-orientated modes of function of singing performance and their higher sensitivity, singers may operate at a more "feelingful" level. In addition, it seems that, as a social group, singers may not experience anger more frequently than other groups, a question that arose taking into account the findings of Averill (1982) that most emotions are dependent on the subject's social context.

Both female and male singers differed from their normative groups on the Anger Expression-In scale. These scores may indicate that both female and male students frequently experience angry feelings but tend to suppress them. Spielberger (1999) drew attention to the fact that high Anger Expression-In scores combined with high Anger Expression-Out scores could mean that these individuals would suppress or express their angry feelings at times. Because their Anger Expression-Out scores are not significantly different, it is an indicator of an attitude of suppressing anger feelings. This was interpreted in terms of the need to refrain from expressing anger overtly in a competitive and hierarchical system such as that of a music college. Therefore, it may be that high levels of Anger Expression-In may be a useful trait for singers in a music college.

The above seems to reinforce the results obtained by Fitness (2000) on anger expression at the workplace. In addition, female singers also scored lower in the Anger Control-In scale, which indicates that they experience angry feelings but show a tendency not to develop internal controls to overcome feelings of anger. Finally, the results showed that there were no significant differences between the singers' State Anger levels prior to and after the performances. Therefore, it was hypothesized that the mid-year examinations did not raise the singers' levels of anger. This may be because they did not feel unfairly treated during the course of their examinations, they enjoy singing, are used to performing, and they feel they are good at it. As singers are frequently subjected to examinations, it may well be that they learn how to adapt and respond to the situation. It may also be that the hypothesized relationship between the emotion of anger and the singing activity is not verifiable, at least in the moment of performance itself.

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References

Averill J. (1982). *Anger and Aggression: An Essay on Emotion*. New York: Springer-Verlag.

Berkowitz L. (1990). On the formation and regulation of anger and aggression: A cognitive neoassociationistic analysis. *American Psychologist*, *45*, pp. 494-503.

Fitness J. (2000). Anger in the workplace: An emotion script approach to anger episodes between workers and their superiors, co-workers and subordinates. *Journal of Organisational Behaviour, 21*, pp. 1147-1162.

Kemp A. E. (1996). *The Musical Temperament: Psychology and Personality of Musicians*. Oxford: Oxford University Press.

Lemerise E. and Dodge K. A. (1993). The development of anger and hostile interactions. In M. Lewis and J. Aviland (eds.), *The Handbook of Emotion* (pp. 537-546). New York: Guilford Press.

Spielberger C. D. (1999). *State-Trait Anger Expression Inventory-2: Professional Manual*. Odessa, Florida, USA: Psychological Assessment Resources.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Appassionata for guitar of Ronaldo Miranda: Relationship between timing variation and musical texture

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The aim of this study was to analyze four commercial recordings of the theme *Lirico e molto espressivo* from Miranda's *Appassionata* for solo guitar. It intends to verify the mathematical behavior of timing variation as a function of the indication of the composer, in two phrases with two parts, each of which contains distinct textures. The selected theme has in its first motif a defined melody and in the second motif an improvised character. Using computer software, the IOIs related to the time unit were obtained. The first group (G1) contained the data regarding the texture of the defined melody, while the second group (G2) contained the data regarding the texture of improvised character. Analysis of variance (ANOVA) verified a significant relationship between the timing variation of the interpreter's performance and the indication from the composer. We conclude that the parabolic curve behavior depends on the structural function of the motif of the phrase. G1 was over-valued by the significant increase in the duration of the notes due to their higher structural importance. G1 tended to have a tighter and slower timing pattern than what was indicated by the composer, and G2 tended to have a higher timing liberty pattern due to their more improvised characteristic.

Keywords: timing; musical texture; statistic analysis; mathematical approaches; acoustic guitar performance

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International Symposium on Performance Science
ISBN 978-90-9022484-8

A comparative study: Editions and manuscripts of the Concerto for Guitar and Orchestra by Villa-Lobos

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This research involved a comparative study among three edited versions of Max Eschig and two manuscripts of the *Concerto for Guitar and Orchestra* by Heitor Villa-Lobos in this article. This was accomplished through a simultaneous comparison among the versions. As a result of this study, a series of divergences emerged and are pointed out. Such study allows us a new look before the piece, increasing its execution possibilities and aiding the interpreters positioning in the performance

Keywords: Villa-Lobos; comparative study; manuscripts; editions

Heitor Villa-Lobos is considered the greatest Brazilian composer in history, and as Ginastera affirmed, "we can say without hesitating, Villa-Lobos is one of the geniuses of America" (Ginastera 1969). His pieces were always creative and innovative, with "brasilidade" and universalism equated in a magisterial way.

A great contribution to the guitar literature is present in his work. This contribution is demonstrated not only by the art and beauty of his compositions, but also by the development of the writing for the instrument, together with the exploration and amplification of the technical and sound possibilities of the latter.

His compositions for guitar have frequently been visited and they are part of the repertoire and discography of the most renowned interpreters, besides being an indispensable part in the academic formations of Brazilian universities and most of the universities and conservatories in the world.

Many books, theses, dissertations, and essays have H. Villa-Lobos and/or his compositions as a theme. However, very little has been written regarding his *Concert for Guitar and Small Orchestra*. In the few works that can be found with comments concerning the piece in question, the unanimity of opinions regarding the importance of this concert is noticeable, being considered the synthesis of Villa-Lobos's guitar writing (Dudeque 1994).

Moreover, reiterating the importance of the piece, Turíbio Santos (1975) states this piece presents a new technical equation. The composer dared and the result was the creation of new procedures.

Eduardo Meirinhos (1997) wrote: "We believe the Concert for Guitar and Small Orchestra, from Heitor Villa-Lobos, to be a synthesis of the technical and musical procedures with regard to the guitar-specific writing."

In spite of the few writings regarding the concert, such recognition has been given through frequent executions and recordings.

The last piece for guitar written by Heitor Villa-Lobos was the *Concert for Guitar and Small Orchestra* composed in 1951, with three movements, and initially entitled *Concertante Fantasy*. In 1955 it was edited by Max Eschig and, due to Andrés Segóvia's insistent requests for a concert and not a fantasy, Villa-Lobos added a cadenza to the end of the second movement and renamed it *Concert for Guitar and Small Orchestra*. Under Villa-Lobos's direction, the concert was premiered in 1956 by Segóvia—to whom it had been dedicated—together with the Houston Symphony Orchestra.

It was composed during a phase in which Villa-Lobos was greatly accepted by critics and the public. Villa-Lobos, at that time, had already traveled to several parts of the world, having acted in areas of music such as research, education, conducting, and composition, and his pieces had been frequently visited by the best orchestras.

The study of this concert, as well as the study of his compositions for solo guitar, is accomplished mainly through Max Eschig's editions. However, contact with the manuscripts and an eventual comparative approach are extremely important, for they unfold new possibilities for the interpreter regarding their execution.

Concerning the accomplishment of a comparative study of this composition for solo guitar, an access to editions of comparative character is vitally important because they serve as guides and enable a positioning of the interpreter toward the piece. Some of these works include: *Manuscript and Printed Sources of the 12 Studies from Heitor Villa-Lobos* (Meirinhos 1997); *The 12 Studies for Guitar from Heitor Villa-Lobos: Revision of the Autograph Manuscripts and Comparative Analysis of Three Interpretations* (Salinas 1993); *Primary Sources and Editions of Brazilian Popular Suit, Chorus No. 1, and Five Preludes, by Heitor Villa-Lobos: Comparative Survey of Differences* (Meirinhos 2002).

The above mentioned works attest to the importance of comparative studies; Eduardo Merinhos (1997) emphasized that musicians should bear in mind "the frequent incompatibility of the manuscripts with the edition." Heeding this, such pieces could be analyzed and countless differences pointed out "to establish a new attitude of the interpreter toward the execution" (Meirinhos 1997).

In that sense and in what concerns our object of study, this research has discovered a lack of literature employing a comparative approach with regards to the *Concert for Guitar and Small Orchestra* by Villa Lobos. In order to remedy this, a comparative study was made which aimed to fill this gap, so far existent, concerning the *Concert for Guitar and Small Orchestra* by Villa-Lobos, and in doing so point out new solutions for its execution.

MAIN CONTRIBUTION

Comparative Study

A comparative study was made using all the three editions by Max Eschig and two manuscripts of the *Concert for Guitar and Small Orchestra* by Heitor Villa-Lobos. From this, focusing on only the guitar parts, a series of divergences were found:

Table 1. Differences found between the manuscripts and the editions by Max Eschig.

Compass/Note	*Manuscript*		*Eschig editions*		
	Full score	*Reduction*	*Full score*	*Reduction*	*Guitar solo*
25/3rd semiquaver	B 4	B 4	Bb 4	Bb 4	Bb 4
30/3rd semiquaver	Gb 2	Gb 2	Gb 2	G 2	G 2
41/1st crotchet	G 3	G 3	G 3	A 3	G 3
43/1st crotchet	F 3	F 3	F 3	E 3	F 3
49/crotchet (in the 3rd time)	G 2	E 2	G 2	E 2	E 2
76/7th quaver	B 3	B 3	B 3	B 3	G 3
87/crotchet (in the 4th time)	C 3	C 3	C 3	Suppressed note	C 3
88/2nd quaver (in the 4th time)	E 4	E 4	D 4	E 4	E 4
104/2nd quaver (in the 2nd time)	C# 4	C# 4	C# 4	C# 4	C 4
105/1st quaver (in the 2nd time)	F# 4	F# 4	F# 4	F 4	F 4

Table 1 (cont.)

Compass/Note	*Manuscript*		*Eschig editions*		
	Full score	*Reduction*	*Full score*	*Reduction*	*Guitar solo*
116/1st minim (in the 2nd duplets)	G 3	G 3	G 3	A 3	G 3
154/punctuated crotchet, linked to the 1st quaver	F 3	F 3	F 3	F 3	F# 3
154/ last quaver	F 3	F 3	F 3	F 3	F# 3
199/4th semiquaver	C# 3	C 3	C# 3	C 3	C 3
199/11th semiquaver	C# 4	C 4	C# 4	C 4	C 4
200/semiquaver (in the 1st & 2nd time)	Ab 3	Ab 3	F 3	Ab 3	Ab 3
200/semiquaver (1st, 2nd, & 3rd time)	F 4	F 4	F# 4	F 4	F 4
201/3rd, 6th, & 9th semiquaver	Db 4	Db 4	Db 4	D 4	Db 4
202/3rd, 6th, & 9th semiquaver	Ab 3	Ab 3	Ab 3	A 3	Ab 3
217/last semiquaver	no indication	harmonic indication	no indication	no indication	harmonic indication
233/10th semiquaver	C 5	C# 5	C 5	C# 5	C# 5
251/last semiquaver	E 2	E 2	E 2	E 2	G 2
310/last quaver	F# 4	F 4	F# 4	F 4	F 4
312/2nd minim	G# 2	G 2	G# 2	G# 2	G# 2
340/punctuated minim and subsequent minim	B 3	B 3	B 3	C 4	B 3
346/3rd group of crotchets	Suppressed note	D 4	Suppressed note	D 4	D 4
354/6th quaver and subsequent quaver	C 5	C# 5	C 5	C# 5	C# 5
357/8th note	A 3	A 3	A 3	F 3	A 3
Cadence/8th minim from the Andante	G 4	/	/	/	Bb 4

IMPLICATIONS

This comparative study enables us to prove the existence of countless differences among the versions. Differences in 25 compasses were found, and in some of them even three notes diverged. Taking into account that in each difference there are two notes, a total of 79 possibilities were found. The first movement of the concert is the one that presents the largest number of differences, and Max Eschig's version (guitar solo) is one of the most divergent in comparison to the others; though, in the second movement there is a smaller incidence of differences, while in the third a larger incompatibility between the manuscripts was verified. The occurrence of divergences did not only happen when the manuscripts and the edited versions were compared, but also between the manuscripts themselves and among the edited versions. Such indications offer a great variety of choices for the interpreter toward the execution, therefore enabling a new perspective of the piece.

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References

Bèhague G. (1980). Villa-Lobos, Heitor. *The New Grove Dictionary of Music and Musicians, volume 26*, pp 613-21. London: Macmillan.

Gilardino A. (1988). *Manuale di storia della chitarra*. Ancona, Italy: Bèrben.

Ginastera A**.** **(**1969). *Presença de Villa-Lobos. Homenagem a Villa-Lobos, volume 3,* pp.23-7. Rio de Janeiro, Brazil: MEC/Museu Villa-Lobos.

Kiefer B. (1986). *Villa-Lobos e o Modernismo na Música Brasileira*. Porto Alegre, Brazil: Editora Movimento.

Mariz V.(1977). *Heitor Villa-Lobos, Compositor Brasileiro*. Rio de Janeiro, Brazil: Fundação Nacional Pró-Memória—Museu Villa-Lobos.

Mariz V. (1994). *História da Música no Brasil*. Rio de Janeiro, Brazil: Editora Civilização Brasileira.

Nobre M. (1988). *Revista do Brasil: Villa-Lobos e a Música Contemporânea Brasileira (Ano 4, No. 1,* pp.36-39). Rio de Janeiro, Brazil: Prefeitura da Cidade do Rio de Janeiro/RIOAR-TE/Fundação Rio.

Norton D. (1994). *História do Violão*. Curitiba, Brazil: editora UFPR.

Meirinhos E. (1997). *Fontes Manuscritas e Impressa dos 12 Estudos para violão de Heitor Villa-Lobos***.** Unpublished masters thesis, São Paulo, Brazil.

Meirinhos E. (2002). *Primary sources and Editions of Suíte Popular Brasileira, Choros No. 1, and Five Preludes, by Heitor Villa-Lobos: A Comparative Survey of Differences*. Unpublished doctoral thesis, Florida, USA.

Paz K. S. (1993). *Os 12 Estudos para Violão de Heitor Villa-Lobos: Revisão dos Manuscritos Autógrafos a Análise Comparativa de Três Interpretações*. Unpublished masters thesis, Rio de Janeiro, Brazil.

Pereira M.(1984). *Heitor villa-Lobos, sua obra para violão*. Brasília, Brazil: Editora Musimed.

Santos T.(1975).*Heitor Villa-Lobos e o Violão*. Rio de Janeiro, Brazil: MEC/DAC—Museu Villa-Lobos.

Villa-Lobos H. (unpublished manuscript). *Concerto pour Guitarre & Petit Òrchestre*.

Villa-Lobos H. (1955). *Concerto pour Guitarre & Petit Òrchestre*. Paris: Editora Max Eschig.

Villa-Lobos H. (1955). *Concerto pour Guitarre & Petit Òrchestre*. Paris: Editora Max Eschig.

Villa-Lobos H. (1971). *Concerto pour Guitarre & Petit Òrchestre*. Paris: Editora Max Eschig.

International Symposium on Performance Science
ISBN 978-90-9022484-8

When gesture sounds: Bodily significance in musical performance

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When gesture sounds is a specific reflection about the awareness of expressive movement as a meaningful and complementary element of sound in live musical performance. Given that movement is the motor of sound and intention the impulse of gesture, the inevitable connection between intentional bodily movements and music emerges, allowing us to establish synaesthesia channels which influence expressiveness, understanding, and communication in performance events. This study expounds an approximation to the cognitive aspects of gesture and its significance in relation to musical practice and perception, considering players and audience. The idea that gesture could act as a visual stimulus to perform and perceive music in a particular way is defended. "Times" of gesture are evaluated, with their implicit intentions and meanings. Finally, an incursion into pedagogy intends to examine what of gesture could be taught and, if so, how.

Keywords: gesture; live performance; expressiveness; pedagogy; synaesthesia

Self-awareness in performance is one of the goals that musicians set themselves to enhance good practice and to achieve a personal and effective version of repertoire (Green and Gallway 1986). This theoretical research tries to show that expressive movements do not occur by chance, even when they appear to be a spontaneous and natural consequence of an irresistible corporal experience while playing a musical instrument. Mind, guided by will, addresses the expressive movements attempting to connect body and music. The body metaphor of sound (Davidson 2002, Snyder 2000) is in this sense the result of an "intelligent feeling." Because knowing develops in mind and mind develops in the brain, some authors argue that "all human knowledge draws its sustenance from corporeal roots" (Bowman 2004). Avoiding hierarchies, what this argument affirms is indisputably the relationship between body and mind in a dependant unit. Production, perception, cognition, and teaching are the explorative domains of expressive gesture.

MAIN CONTRIBUTION

This research focuses attention on channels of significance (not in a semantic level but in an association one) that emerge when players and audience connect *gesture* with some specific musical parameters, such as character, articulation, quality, and intensity of sound. Players build this connection into a holistic musical performance through a mental process that guides their understanding of musical discourse and their non-verbal expression, while the audience constructs it in a global perception via imagination. The result of this significance may be explained in multiple terms including sensitivity, culture, and musical understanding. A further question, for later research, emerges at this point: does the relationship between music and gesture necessarily coincide for both performer and listener? Apart from sharing the sensitivity, culture, and musical understanding referred to above, any attempt at an answer would have to bear in mind the performer's intention (Hermerén 1993) and the empathy between performer and audience.

Perceptive dimensions in live performance

In all live performances, two sensorial dimensions exist—the aural and the visual—in which musicians and audience are involved together, performing and perceiving respectively. Obviously, sound is the greatest result of performance but, as we know, sound is essentially movement. Nothing sounds if nothing is in movement (Fernández 2000). The motor of sound, which makes instruments vibrate, is the performer's movement, or in other words when a proper combination of skeleton, muscles, nerves, and circulation (Ortmann 1962) occurs. The implementation of a sort of body choreography, which includes one kind of intentional movement, the *gesture*, is what some researchers have appointed as "body language" (Davidson 2002, Dhal and Friberg 2007).

Gesture does not really sound, but it represents the factual objectivity of the sound related to its visual perception. To the question "what is, then, what performers do?", Eric Clarke (2002) responds: "in one stage…they produce physical realizations of musical ideas". And Wayne Bowman (2004, p. 38), writing about cognition and the body, assures that "perception of musical gesture is invariably a fundamental part of what the music, fully perceived, is." We have now, not only a gesture, but a "musical gesture" (Chaffin *et al.* 2007). Two kinds of gesture exist in performance: technical and expressive. The first is necessary to produce sound, overcoming mechanical challenges. The second one is not essential to produce sound but complementary to the combinations of sound qualities in order to feel or communicate expression. When both co-exist, and are perceived as one, the experience of performance becomes free and, paradoxically, the fusion between player and instrument reveals the symptoms, not their realities, of music's existence; those that Claude Debussy found "among notes."

To see is to perceive. Seeing performers' gestures as they play strongly influences the particular kind of data registration that accompanies the listening in the total perception of the performance.

Connections between performer, art of performance, and gesture

By taking into account the performers' gesture, we are assuming and respecting their identity as "music makers" (Elliot 1995) and not only as "music transmitters." The role of a performer is not exclusively an executive demand of music to sound, although some exceptional musicians thought this. Ravel and Stravinsky asked performers to "translate" (execute) the score into sound, which implied a resolute attempt to make their own personalities invisible. This is not the commonly accepted theory of performance however (Urmsom 1993). Nowadays, performing is an art (Kivy 1995, Mark 1981), and more ambitiously we say that "music is a performing art" (Elliot 1995, p. 165). The clearest example that supports the assertion that gesture represents sound is the conductor's work. When conductors move, they produce gestures making a physical and a mental effort to express music with their bodies. In the solitude of a conductor's personal practice, when music still does not sound through an orchestra, is when the paradigm of gesture sonority appears.

Artists ceased long ago to be the intermediate hand between the muses and the real world and now we have no doubts that when someone is involved in an artistic process, the result depends on his or her personality. One of the singularities of an artistic presentation is its uniqueness. Gesture can be learned, even imitated, but it will never be the same in different individuals because it is part of one's personality. It is important to clarify that gesture does not refer to simple gesticulation, mimicking, or theatricality with independence of sound, although it could be analyzed as a "nonsonic aspect of musical performance" (Kivy 1995). The pathway has been that sound is motion, intentional motion is gesture, and expressive gesture represents the metaphor of musical expressiveness in performance. Expressiveness is an aesthetic characteristic of music and, in terms of aesthetic appreciation of gesture, we could observe the elegance, power, sophistication, or discretion of its expression as a beauty sign that only a performer's personality may show.

Times of gesture: implicit intentions

When discussing times of gesture in relation to sound, we can distinguish three moments: time before, parallel time, and time after. While in the time before, the gesture represents the anticipation of musical technical need or expression, in the parallel time this gesture accompanies and is seen contemporarily to the sonorous discourse. When sound is free of any real practical execution, expressive gesture may explain or resolve the expression of sound in the time after. Tracing a simile, expressive gesture in the parallel time could be comparable to the modal complement of a sentence and in the time before and after the verb. Expressive and technical gestures exist in time before and in parallel time, but in time after the truly valid and reasonable possibility is to produce and perceive expressive gestures.

Time before is clearly perceived when a performer is about to play, and manifested in "take impulse" breathing, preparing his or her fingers, arms, or body position, looking around, coming into contact with the instrument, initiating a movement in air, etc. The information contained in this kind of gestures is completely intentional and it warns us about what is going to happen with the coming sound. Parallel time is that in which *gesture* develops itself in the real dimension of musical performance art: the present time. Music, as is any kind of sound, is fleeting, compared to material things. In musical performance, neither the past nor the future exists. Even ideas have past and future: both the past and the future of three plus two are five. The past of the ensuing performance rests on the one hand on the idea of the composer and on the other hand on the score, being its future and its own past. In this context of inevitable "present-ness" of sound, the parallel gesture is shown. Finally, in the time after, gesture becomes significant again, evoking the *past present* of performance.

Gesture in pedagogy

We can deduce from everything said above that to perceive, feel, or understand music, it is crucial to perceive, feel, and understand our body, referring back to awareness. The educational amalgam between body and music, human being and art, physical and aesthetic, has been defined by Richard Shusterman (2004) as "somaesthetic." Of course, we are born with certain instinct of abstraction, which can mean that what we perceive, feel, or understand instrumental practice or musical listening, which could be conceptualized as well as described. However, we are immersed in multiple contexts (Elliot, 1995) and it is not easy to take part of a non "natural" context as music is, in which abstraction requires a complex effort of perception and cognition. Essential parameters of music, sound, and rhythm are part of the nature of our body expression, but the way to combine them into systems is the result of many cultural constructs. We are not born knowing a culture, so music, as a cultural construction, should have a training stage in which the understanding of its cultural meaning is elaborated. The elaboration around the comprehension of gesture as an image of music needs again not a "natural" but a cultural intervention: method.

Method in music's pedagogy includes the *hows* of practicing. The basic strategies to teach students how to feel, enjoy, produce, and convince with expressive gestures are usually to initiate them in imitation of gestures in order to develop their own inspiration in their future movements. Some of these strategies include discussing with students their video tape recordings or mirror visualizations, guiding with physical contact the students' body segments in their movements, adding verbal metaphoric information to the gestures shown, offering students the opportunity to teach what they know and "interpret" about gesture by giving classes to other students, and urging students to use their bodily expression, freely and consciously, connecting it with a new vital dimension in any physical action: not aural, not visual, but spatial.

IMPLICATIONS

Expressive gestures do not supplant the contents of music, in spite of the "musical concerts of gestures" that Milton Estomba, the character of Mario Benedetti's *Cuento*, *La expression* (*Story*, *The expression*) gave every Saturday. Music is sound, first and over all, but a live concert experience. Gestures are part of a range of human reactions to feeling, sensation and comprehension, and to underestimate them in live performance would mean to ignore human signals in a human invention, which is what music is.

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References

Bowman W. (2004). Cognition and the body: Perspectives from music education. In L. Bresler (ed.), *Knowing Bodies, Moving Minds* (pp. 29-50). Dordrecht, The Netherlands: Kluwer Academic Publisher.

Chaffin R., Lemieux A., and Chen C. (2007). "It is different each time I play": Variability in highly prepared musical performance. *Music Perception, 24*, pp. 455-472.

Clarke E. (2002). Understanding the psychology of performance. In J. Rink (ed.), *Musical Performance: A Guide to Understanding* (pp. 81-94). Cambridge: Cambridge University Press.

Dahl S. and Friberg A. (2007). Visual perception of expressiveness in musician's body movements. *Music Perception, 24*, pp. 443–453.

Davidson J. (2002). The language of the body during performance. In J. Rink (ed.), *Musical Performance: A Guide to Understanding* (pp. 173-182). Cambridge: Cambridge University Press.

Elliot D. J. (1995). *Music Matters. A New Philosophy of Music Education.* Oxford: Oxford University Press.

Fernández M. (2000). *Acústica para todos, ¡incluidos los músicos!* Vitoria-Gasteiz, Spain: Producciones Agruparte.

Green B. and Gallway T. (1986). *The Inner Game of Music.* London: Pan Books.

Hermerén G. (1993). The full voic'd quire: Types of interpretation of music. In M. Krausz (ed.), *The Interpretation of Music: Philosophical Essays* (pp. 9-32). Oxford: Oxford University Press.

Kivy P. (1995). A*uthenticities: Philosophical Reflections on Musical Performance.* Ithaca, New York, USA: Cornell University Press.

Mark T. C. (1981). The philosophy of piano playing. *Philosophy and Phenomenological Research, 41,* pp. 299- 324.

Ortmann O. (1962). *The Physiological Mechanics of Piano Technique*. New York: E.P. Dutton.

Shusterman R. (2004). Somaesthetic and education: Exploring the terrain. In L. Bresler (ed.), *Knowing Bodies, Moving Minds* (pp. 29-50). The Netherlands: Kluwer Academic Publisher.

Snyder B. (2000). *Music and Memory*. Cambridge, Massachusetts, USA: MIT Press.

Ursom J. O. (1993). The ethics of musical performance. In M. Krausz (ed.), *The Interpretation of Music: Philosophical Essays* (pp. 157-164) Oxford: Oxford University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The roles of expertise and partnership in collaborative rehearsal

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The cognitive and social processes underlying collaborative rehearsal were explored in a case study using four singer-piano duos, two professional and two student groups. Participants rehearsed one song with their regular partners, a second song with a new partner of the same level of expertise, and a third song with a new partner of a different level of expertise. Verbal discourse during rehearsal was analysed to determine (a) styles of interaction and (b) salient musical dimensions. In the regular and new same-expertise partnerships, the professionals were more likely to give opinions than the students, much of whose talk concerned orientation about the song. In the new mixed-expertise partnerships, the professionals initiated more exchanges and offered more opinions than the students. Socio-emotional behavior reflected tension release, and the pianists gave frequent statements of solidarity to the singers. Basic, interpretive, and expressive musical dimensions were salient, as in previous studies. A range of rehearsal strategies was identified, although the most common was working from the beginning to the end of the song. Future research aims to identify other effective short-term rehearsal strategies and the use of physical gestures in collaborative practice.

Keywords: ensemble; rehearsal; collaboration; content analysis; singers

What is the nature of social and musical interaction in collaborative rehearsal? Over the past several decades, musicians' practice strategies have been identified and explored along with the social and cognitive processes underlying them. Much of this work has focused on solo performers, especially pianists (e.g. Chaffin *et al.* 2002) and singers (e.g. Ginsborg 2002). Little research to date has been undertaken to investigate the nature of collaborative practice, which is surprising given that many musicians work in ensembles as well as independently. The present project builds on existing studies of ensemble rehearsal (e.g. King 2006). The relationships between singers and pianists, and their roles (whether the pianist is coach, accompanist, new or regular duo partner) merit particular attention.

This study investigates differences in short-term performance preparation by singers and pianists of different levels of expertise and familiarity as duo partners. Two research questions were posed: (1) how do musicians of different levels of expertise compare when they collaborate in ensemble rehearsal and performance and (2) how do established and new duo partnerships compare when they collaborate in ensemble rehearsal and performance? An observational case study was carried out using four singer-piano duos: two established professional duos and two established student duos. The participants were asked to prepare a short song individually prior to rehearsing and performing it (1) with their regular duo partner (established/same-expertise), (2) with a new duo partner of the same level of expertise (new/same-expertise), and (3) with a new duo partner of a different level of expertise (new/mixed-expertise).

This paper reports selected findings from the data, specifically the number of verbal exchanges in rehearsals, and content analyses of utterances.

METHOD

Participants

Four established singer-piano duos took part, each comprising a female soprano and a male pianist: Amanda and Colin (mean age=68 years, experience together=10 years, expertise level=professional); Isobel and George (mean age=57, experience together=15 years, expertise level=professional); Betty and Robert (mean age=25.5, experience together=2 years, expertise level=student); Sophie and Guy (mean age=21.5, experience together=2 years, expertise level=student). All participants' names are pseudonyms.

Materials

Three songs by Ivor Gurney (1890-1937) of similar length and level of difficulty were rehearsed (see below). All were unknown to the participants, although they had performed other works by the same composer.

Procedure

Each participant undertook two sessions lasting around 90 minutes on separate occasions. In session 1, they rehearsed and performed *An Epitaph* with their regular partner; in session 2, they rehearsed and performed *On the Downs* with a partner from the other same-expertise duo. Four participants then undertook a third session in which they rehearsed and performed *I Shall be Ever Maiden* with a partner from a different-expertise duo. Each session was video-recorded.

RESULTS

The number of verbal exchanges that occurred between episodes of singing and/or playing in each rehearsal was calculated. These varied from as few as 1-2 to 46. The speaker of the first utterance was also noted. Second, each utterance was coded according to two frameworks: (1) Bales's (1999) *Interactive Process Analysis* (IPA) and (2) *musical dimensions* (based on Chaffin *et al.* 2002, Ginsborg *et al.* 2006). Coding of the first rehearsal transcript was made independently by the two researchers and tested for inter-rater reliability using Cohen's kappa: 0.95 (IPA) and 0.97 (musical dimensions). The other transcripts were subsequently shared out and coded independently.

Verbal exchanges and initiators

The number of verbal exchanges in each 40-minute rehearsal varied from 27 and 62, with one exception. Amanda and Colin (established professional duo) used only half of the available rehearsal time, producing only 13 exchanges, 9 (69%) initiated by Amanda. In the other rehearsals, the singers and pianists initiated roughly equal numbers of exchanges, but in the new mixed-expertise duo rehearsals, the professional participants initiated the majority of exchanges (e.g. George, professional pianist, initiated 71% of exchanges with Betty, student singer).

Styles of interaction

The following codes were used for the analysis of meta-cognitive statements reflecting positive and negative socio-emotional interaction (examples provided in brackets): agrees ("Yes, I guess so"), shows solidarity ("It's lovely, go on"), tension release (laughs), offers apology ("Sorry, that was me"), disagrees ("I don't see that in the harmony"), shows tension ("Aaargh"). No example of "shows antagonism" (Bales 1999) was found.

In all the duo rehearsals, the bulk of socio-emotional interaction was positive, and utterances were categorized most often as "agrees." In the established duos, all the singers agreed more often than did their regular pianists. The pattern was more variable for the new same-expertise duos: Guy (student pianist) agreed more often than Betty (student singer); Isobel (professional singer) and Colin (professional pianist) agreed to a similar extent. In the new mixed-expertise duos, the students agreed more often than did the professionals. Interestingly, there were relatively high proportions of utterances coded as showing solidarity in the student rehearsals (e.g. 23.5% and 30.7% for Guy and Sophie working together). One explanation is that all the students were familiar with one another as friends, even if not as duo partners. Yet, while the professional musicians were also friends, they offered solidarity less often. For George and Betty, one of the mixed-expertise duos, tension release (e.g. laughter) was more frequent than solidarity. Thus familiarity and expertise can impact in different ways upon musicians' socio-emotional behavior: the experienced (professional) musicians in our sample offered less solidarity toward one another, whether familiar or unfamiliar with working together; the less experienced (student) musicians offered more solidarity toward one another, whether familiar or unfamiliar with working together; the mixed-expertise musicians working together for the first time agreed with each other more often than they showed solidarity, but one duo at least showed more tension release than solidarity.

The following codes were used for task-related discourse: asks for opinion ("I wasn't making enough difference there, was I?"); asks for orientation ("Can you play that C# so I can get it?"); gives suggestion ("Let's go from…"); gives opinion ("The phrasing's easier in two"); gives orientation ("I'm breathing before 'in the west'"). No example of "asks for suggestion" (Bales 1999) was found. The professional musicians gave more opinions than the students (range 26.9-45.8% professionals; 6.6-18.1% students). In contrast, the students were more likely to provide orientation, such as correcting errors and clarifying locations (range 8.4-26.4%). Interestingly, mixed-level duos produced higher frequencies of opinion than orientation or suggestion, with the professional giving more opinions than the student; however, the latter offered more opinions than when working with a peer.

Musical dimensions

Verbal utterances were coded according to four types of musical dimension: basic, interpretive, expressive, and strategic. Sub-categories were provided for each, except expressive, as these referred to the implementation of

Table 1. References to musical dimensions with frequency/number of participants.

Dimension	*Sub-category (frequency/no. of participants)*
Basic	Pitch (130/8), tempo (125/8), technique (76/7), breath (71/8), ensemble (66/8), rhythm (58/6), harmony (40/4), composition (40/4), dynamics (37/5), words (30/7), notation (20/4), meter (12/4), figuration (12/4), entries (6/3), instrument (5/2), articulation (2/2), structure (5/2)
Interpretive	Rubato (171/8), dynamics (89/8), words (69/6), tempo (25/6), articulation (14/5), phrasing (15/5), energy (13/5), climax (11/4), color (9/4), pedal (3/1), harmony (3/1), meter (1/1)
Strategic	Whole song (56/8), repeat bar/phrase (46/4), learning strategy (19/4), slower tempo (14/4), rehearse by phrase (11/3), chord and vocal line (10/3), rehearse by verse (6/2), rehearsal time/pace (5/3), rehearse by bar (1/1)

interpretive decisions. Frequencies of utterances (from high to low) for each type/sub-category are shown in Table 1.

The professional musicians talked more about basic than interpretive dimensions, and rarely about expressive and strategic dimensions. The established student duos contrasted with each other: Betty and Robert focused more on basic than interpretive issues but Sophie and Guy discussed interpretive issues more often than basic issues. Yet when Sophie worked with Robert, she made no references to interpretation. In the mixed-expertise duos, over 50% of utterances related to basic dimensions, but over 20% reflected strategic issues, indicating the need to exchange ideas about rehearsal method.

DISCUSSION

This case study was devised to explore collaborative practice among singer-piano duos working in established and new partnerships, and across similar and different levels of expertise (student/professional). Time was used very differently by each duo: some wanted more or less rehearsal time, the students worked in shorter bursts than the professionals, and the professionals produced fewer verbal exchanges. Established and new duo partners initiated similar proportions of dialogue, effectively sharing the direction of the rehearsal, although professionals began more episodes than students in mixed-expertise partnerships. Socio-emotional interaction was largely positive, perhaps because participants felt they had to be pleasant in the somewhat artificial setting of a one-off video-recorded rehearsal. Singers, especially, showed solidarity toward their regular pianists, and tension was released particularly by one of the mixed-expertise duos. Professionals offered more opinions than students, albeit comparatively fewer when working with students; students offered plenty of orientation when working with peers but more opinions when working with professionals, hence establishing a middle ground.

The musical dimensions discussed in these rehearsals are similar to those observed in previous research. Relative attention to these dimensions, especially basic and sometimes interpretive, reflected the individual concerns of musicians, as the interests of one influenced the other. The lack of familiarity and comparability of experience among musicians in new mixed-expertise duos led to more frequent references to strategic dimensions than was evident in other rehearsals. Further analyses of data—e.g. the portions of music actually played and sung, errors, and non-verbal communication such as glances and gestures—are necessary in order to provide deeper insights into collaborative rehearsal and performance.

Acknowledgments

The authors would like to thank the participants and recording and IT technicians.

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References

Bales R. F. (1999). *Social Interaction Systems: Theory and Measurement.* New Brunswick, New Jersey, USA: Transaction Publishers.

Chaffin R., Imreh G., and Crawford M. (2002). *Practicing Perfection: Memory and Piano Performance.* Mahwah, New Jersey, USA: Erlbaum.

Ginsborg J. (2002). Classical singers memorizing a new song. *Psychology of Music, 30,* pp. 56-99.

Ginsborg J., Chaffin R., and Nicholson G. (2006). Shared performance cues in singing and conducting: A content analysis of talk during practice. *Psychology of Music*, *34*, pp. 167-192.

King E. C. (2006). The roles of student musicians in quartet rehearsals. *Psychology of Music*, *34*, pp. 262-282.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Musical performance anxiety as a form of social anxiety?

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The aim of the current study was to investigate the relationship between social anxiety and musical performance anxiety (MPA). Previous literature has reported mixed results concerning correlations between social anxiety and MPA. To better describe overlapping and unique features in comparison with social anxiety disorder may introduce new options for treatment. The aim of the current study was to explore if performance anxiety only, or also the fear of social interaction, predicts MPA and if there are additional predictors beyond social anxiety. One hundred and forty-two music students and professional musicians participated in the study. In addition to questionnaire measures of MPA and social anxiety, we assessed perfectionism, self-focused attention, and absorption as possible predictors. Social anxiety correlated highly with MPA. In a regression analysis only the subscale performance anxiety, not fear of social interaction, predicted MPA. Moreover, social anxiety only partially predicted MPA; perfectionism and public self-focus significantly increased the explained variance. We conclude that social anxiety and MPA are strongly related but are also unique in many ways.

Keywords: musical performance anxiety; social anxiety; multiple regression analysis; perfectionism; self-focused attention

Between 16% and 40% of all musicians suffer from MPA (Fehm and Hille 2005, Wesner and Roland 1990). MPA affects not only the well-being of a musician, but can also damage a musician's career. Although there is a great demand for treatment, MPA is not well understood. Some authors describe MPA as a type of social phobia, characterized by the fear of negative evaluation (e. g. Wilson and Roland 2002, Barlow 2002). Others found only low correlations between social phobia and MPA (e.g. Osborne and Franklin 2002, Steptoe and Fidler 1987), or correlations were limited to certain performance conditions (Cox and Kenardy 1993, Fogel 1982).

Likewise, it is not known if the degree to which other personality traits are relevant in MPA or social anxiety differ. Personality traits, which are linked to both problems, are catastrophizing cognitions (Steptoe and Fidler 1987), perfectionism (Mor *et al.* 1995; Kenny *et al.* 2004), and public self-focus (Schröder and Liebelt 1999). However, it has not been examined if these traits are redundant in the overlap of MPA and social anxiety or if they provide additional information.

The aim of the current study was therefore to better describe overlapping and unique features in comparison with social anxiety disorder. Because social anxiety and its therapy are better explored than MPA, this knowledge may help to identify new options for the treatment of MPA.

METHOD

Participants

For this study, 142 instrumentalists of classical music (83 female) participated. Of those, 72 were music students, and 70 were professionals. Ages ranged from 17 to 65 years; the mean age of the sample was 30 years (SD=9.7).

Materials

The following questionnaires were used:

- Performance Anxiety Questionnaire (German version, BAF: Fehm and Hille 2002)
- Liebowitz Social Anxiety Scale in the self-assessment version (German version: Stangier and Heidenreich 2004)
- Frost Multidimensional Perfectionism Scale (German version: Altstötter-Gleich and Bergemann 2006)
- Hewitt and Flett Multidimensional Perfectionism Scale, Subscale Socially Prescribed Perfectionism (German Version: Stöber 2002)
- Self-focused Attention (SAM; Filipp and Freudenberg 1989)
- Tellegen Absorption Scale (German version: Ritz and Dahme 1995)
- Questions on socio-demographic background and musical training

Procedure

Musicians in music colleges and orchestras were invited to participate in the study. The rate of questionnaires sent back by mail was 91%. Differences between students and professionals were analyzed with univariate analyses of variance (ANOVAs). Significant effects were followed up by *t*-tests using the Bonferroni correction. A significance level of alpha (α)=0.05 was used for all analyses. To examine the unique contribution of traits, we used stepwise multiple regression analyses.

RESULTS

The mean musical performance anxiety (MPA) score (BAF) of all participants was in the medium range (M=51, SD=12.8; possible range 20-100, normative mean of music students M=55, SD=12.3; Fehm *et al.* 2005). Music students had higher MPA than professionals, $F(2,139)=5.15$, $p<0.01$. Also, in line with previous studies, women indicated higher MPA than men, $t(140)=-3.35$; $p<0.001$.

All subscales of social anxiety (LSAS) highly correlated with MPA ($r=0.50$, $p<0.001$), but in a stepwise regression analysis, only the subscale performance anxiety remained significant (see Table 1). Neither avoidance behavior nor fear and avoidance of social interaction situations made any additional contribution to the prediction. Social anxiety predicted 24% of MPA ($R^2=0.24$). Moreover, social anxiety only partially predicted MPA; other personality traits and characteristics significantly increased the explained variance by about 15%. Beyond the LSAS subscale performance anxiety, gender, public self-focus, the belief that the audience likes the performance, the professional status, and perfectionism were additional predictors. Absorption, private self-focus, fear of social interaction, as well as socially predicted perfectionism did not predict MPA.

DISCUSSION

The central finding of this study was that social anxiety and MPA are strongly related but also unique in several ways. Performance anxiety, not fear of social interaction, predicts MPA in a multiple regression. Moreover, social anxiety does not predict MPA completely. In addition to social anxiety, perfectionism, public self-focus, gender, the professional status, and the belief that the audience likes the performance seem to be essential for the extent of MPA. Whereas self-focused attention (Clark and Wells 1995) and perfectionism (Juster *et al.* 1995) are known to be related to social anxiety as

Table 1. Stepwise regression analysis with MPA as dependent variable, R^2=0.39.

Questionnaire	*Subscale*	β
Liebowitz Social Anxiety Scale (LSAS)	Performance anxiety	0.33***
Socio-demographic data	Gender	0.18*
	Profession	-0.18*
	Belief that audience likes the performance	-0.21***
Self-focused Attention (SAM)	Public self-focus	0.17*
Multidim. Perfectionism Scale (MPS-F)	Concern over mistakes	0.18*

* p<0.05, ** p<0.01, *** p<0.001

well, there is usually no relationship between gender or professional status and social anxiety.

Different from our expectation, absorption and MPA did not correlate significantly. We assumed that absorption (see Tellegen and Atkinson 1974) is related to the positive experience while performing, leading to a greater attention and involvement in the musical experience and the incidence of flow experiences, which are frequently expected to reduce MPA (Wilson and Roland 2002). However, a study of Lilienfeld (1997) showed that absorption can also be related to anxiety sensitivity. Perhaps absorption is related to emotional involvement concerning both positive and negative emotions and does not therefore reduce MPA.

The finding that MPA is higher among students than among professionals is in line with previous work (Steptoe and Fidler 1987). As there is no effect of age among the group of students or among the group of professionals in this study (although the latter are equally distributed from 25 to 65 years), we suggest that the professional status is indeed the critical factor for MPA, not age or performance experience.

In sum, the results suggest that MPA is a special subtype of social anxiety. It seems to be justifiable to transfer knowledge related to social anxiety to develop better treatments for MPA. However, those approaches will have to be adapted to the special features of MPA, especially perfectionism and public self-focus.

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References

Altstötter-Gleich C. and Bergemann N. (2006). Testgüte einer deutschsprachigen Version der Mehrdimensionalen Perfektionismus Skala von Frost, Marten, Lahart und Rosenblate (MPS-F). *Diagnostica 52,* pp. 105-118.

Barlow D. H. (2002). *Anxiety and its Disorders* (2nd ed.). New York: Guilford Press.

Clark D. M. and Wells A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, and F. R. Schneier (eds.), *Social Phobia: Diagnosis, Assessment, and Treatment* (pp. 69-93). New York: Guilford Press.

Cox W. J. and Kenardy J. (1993). Performance anxiety, social phobia and setting effects in instrumental music students. *Journal of Anxiety Disorders, 7,* pp. 49-60.

Fehm L. and Hille C. (2005). Bühnenangst bei Musikstudierenden. *Verhaltenstherapie und Verhaltensmedizin, 26,* pp. 199-212.

Filipp S. H. and Freudenberg E. (1989). *Fragebogen zur Erfassung dispositionaler Selbstaufmerksamkeit (SAM).* Handanweisung. Göttingen: Hogrefe.

Fogel D. O. (1982). Toward effective treatment for music performance anxiety. *Psychotherapy: Theory, Research, and Practice, 19*, pp. 368–375.

Juster H. R., Heimberg R. G., Frost R. O., *et al.* (1995). Social phobia and perfectionism. P*ersonality and Individual Differences, 21,* pp. 403-410.

Kenny D. T., Davies P. J., and Oates J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *Journal of Anxiety Disorders, 18,* pp. 757–777.

Lilienfeld S. O. (1997). The relation of anxiety sensitivity to higher and lower order personality dimensions: Implications for the etiology of panic attacks. *Journal of Abnormal Psychology, 106,* pp. 539-544.

Mor S., Day H., and Flett G. (1995). Perfectionism, control, and components of performance anxiety in professional artists. *Cognitive Therapy and Research, 19*, pp. 207-225.

Osborne M. S. and Franklin J. (2002). Cognitive processes in music performance anxiety. *Australian Journal of Psychology 54,* pp. 86-93.

Ritz Th. and Dahme B. (1995). Die Absorptions-Skala: Konzeptuelle Aspekte, psychometrische Kennwerte und Dimensionalität einer deutschsprachigen Adaptation. *Diagnostica, 41,* pp. 53-61.

Stangier U. and Heidenreich T. (2004). Die Liebowitz Soziale Angst-Skala (LSAS). In *Collegium Internationale Psychiatriae Scalarum (Hrsg.), Internationale Skalen für Psychiatrie.* Weinheim: Beltz.

Steptoe A. and Fidler H. (1987). Stage fright in orchestral musicians: A study of cognitive and behavioural strategies in performance anxiety. *British Journal of Psychology, 78*, pp. 241-249.

Stöber, J. (2002). Skalendokumentation “Persönliche Ziele von SchülerInnen”. In C. Dalbert (ed.), *Hallesche Berichte zur Pädagogischen Psychologie Nr. 3*. Halle (Saale), Germany: Institut für Pädagogik, Martin-Luther-Universität Halle-Wittenberg.

Tellegen A. and Atkinson G. (1974). Openness to absorbing and self-alterating experiences (“absorption”), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology, 83,* pp. 268-277.

Wesner R. B., Noyes R., and Davies T. L. (1990). The occurrence of performance anxiety among musicians. *Journal of Affective Disorders, 18,* pp. 177-185.

Wilson G. D. and Roland D. (2002). Performance anxiety. In R. Parncutt and G. E. McPherson (eds.), *The Science and Psychology of Music Performance* (pp. 47-61). Oxford: Oxford University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Not quite so healthy: The lifestyles of music conservatoire students

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The general health-promoting behaviors and health problems of students at music conservatoires were investigated via an online survey completed by a total of 272 students from the Royal Northern College of Music (RNCM, n=199) and the Royal College of Music (RCM, n=73). The Health-Promoting Lifestyles Profile (HPLPII) was administered in combination with an ad hoc inventory on musculoskeletal pain and selected psychosomatic problems. The present study further explores (a) the differentiation of subgroups of the sample on the basis of levels of self-reported health-promoting behaviors and (b) the influence of musculoskeletal (MS) and non-musculoskeletal (NMS) problems on practice and performance quality. Cluster analysis of participants' responses identified one group performing above and one group below average for scores representing the frequency of engagement in health-promoting behaviors. No differences were found between these groups in relation to other health-related variables. Concurrent health issues, especially when MS and NMS problems occurred simultaneously, significantly influenced self-reported practice and performance quality. These results suggest that healthy lifestyles *per se* do not predict the amount of actual health issues. The accumulation of health problems, however, has measurable subjective influence on practice and performance quality.

Keywords: health-promoting lifestyles; students; music performance; musculoskeletal pain; psychosomatic symptoms

Professional musicians, including music students, are prone to health problems as both a direct and indirect result of practice and performance on their individual instruments (e.g. Wynn Parry 2004). Thus, the self-promotion of physical and mental health and wellbeing should be a primary strategy for developing and maintaining musical excellence.

To investigate this notion, the general health-promoting behaviors and health problems of students at music conservatoires were addressed in an online survey along with additional psychological variables. Levels of healthy behaviors and their relationship to self-efficacy, self-regulation, and affective state were assessed (Kreutz *et al.* in press), as well as relationships between psychometric measures and incidences of health problems among different groups of instrumentalists (Kreutz *et al.* submitted). Results showed varying levels of healthy behaviors among students with respect to different subscales of the HPLPII inventory. In particular, values for health responsibility, physical activity, and stress management were below average, whereas somewhat higher values were observed for nutrition, interpersonal relationship, and spiritual growth. Significant correlations were observed between healthy behaviors and the psychological variables, which indicated mutual influences between these behaviors and self-beliefs as well as emotional state. Approximately half of the sample was affected by at least one incidence of above average or severe musculoskeletal pain and one incidence of a non-musculoskeletal (psychosomatic) symptom. Factor analysis of health problems produced a six-component solution, five of which were related to musculoskeletal pain, and one was related to symptoms of fatigue. These factor scores accounted for totals of between 15% and 27% of variance explained in a regression analysis to predict practice and performance quality (Kreutz *et al.* submitted).

The present study was designed to extend the previous reports. Specifically, I sought (1) to explore further the relationship between individuals' levels of healthy behaviors and incidences of health issues and (2) to identify any influence of health issues on self-reported measures of practice and performance quality.

METHOD

Participants

A total of 273 students (174 female, 99 male; mean age=21.94 years, SD=3.15) from the RNCM (n=199) and the RCM (n=74) responded to the survey. They represent approximately 29.7% (RNCM) and 10.6% (RCM) of the total student populations at these conservatoires.

Materials

A battery of questionnaires was administered. The first was designed to collect basic demographic information: age, sex, affiliation to one of the two conservatoires, year of study, main instrument played, and estimated hours of practice undertaken each week. The instruments used to measure the variables of interest were the Health-Promoting Lifestyle Inventory (HPLPII) and a self-developed inventory on musculoskeletal and non-musculoskeletal symptoms. The HPLPII measures the frequency of engagement in health-promoting behaviors. It consists of 52 items that are rated on a 4-point Likert-type scale: 1 (never), 2 (occasionally), 3 (frequently), and 4 (routinely). Scores for all items thus range from 52 to 208 with a midpoint of 130 (Walker *et al.* 1987). This instrument provides a total score for health-promoting behavior, as well as six subscales (see "Results"). Musculoskeletal and non-musculoskeletal symptoms were rated on a 5-point Likert-type scale: 1 (non-existent), 2 (below average), 3 (average), 4 (above average), and 5 (severe). Finally, participants rated their perceived practice and performance quality over the past week on similar 5-point Likert-type scales. Specifically, it was asked whether they were able to practice with their usual technique, spend their usual amount of time practicing and performing, and whether they were able to practice and perform up to their usual standard.

Procedure

Participants were invited via e-mail to take part in a survey, referred to as the "RNCM/RCM Health Survey." The survey itself was constructed using the environment provided by Surveymonkey© to which the measurement instruments were adapted. First, the welcome page informed the respondents about the nature, purpose, and scope of the study and provided an opportunity to give informed consent. Respondents provided basic demographic and musical background information on the next pages. All respondents were then directed to the inventories, of which the HPLPII and the specially constructed health survey are relevant to the present study.

RESULTS

To check whether any subgroups among the participants with varying levels of health-promoting lifestyles could be identified, the frequency distribution was plotted by means of a histogram representing 0.2 scale-steps per bar. Visual inspection suggested the presence of two peaks within this distribution. To explore this possibility further, a hierarchic cluster analysis

Table 1. Means (and SD) of HPLPII total and subscale scores for the clusters *A* (n=49) and *B* (n=199).

HPLPII	*Cluster A*	*Cluster B*	*t-value*
Total	2.32 (0.29)	3.05 (0.18)	18.07*
Health responsibility	1.65 (0.37)	2.50 (0.51)	13.19*
Physical activity	2.06 (0.54)	2.80 (0.58)	8.37*
Stress management	2.12 (0.39)	2.71 (0.48)	9.15*
Nutrition	2.58 (0.52)	3.38 (0.32)	10.20*
Interpersonal relations	2.82 (0.49)	3.47 (0.38)	8.45*
Spiritual Growth	2.75 (0.50)	3.45 (0.35)	9.22*

* p<0.001

procedure was performed on the data using the median method. A solution comprising two clusters was found to converge after four out of ten iterations. The mean difference of the two clusters was significant, $t(243)=16.72$, $p<0.001$. A repeated measures analysis of variance (ANOVA) was performed in which the two clusters served as independent variables and the values for the six subscales of the HPLPII were entered as dependent measures. A significant and robust main effect of subscale was observed, $F(5,1215)=174.49$, $p<0.0001$, partial $\eta^2=0.42$, while the interaction between subscales and cluster variables only approached significance, $p=0.09$, suggesting that the score differences are consistent across the individual subscales. In fact, mean comparisons of each subscale revealed significant differences across all aspects of healthy behaviors, all $t(243)>8.03$, $p<0.001$. Table 1 summarizes the means of HPLPII scores (total and subscales) for the two clusters and t-values from the comparison of means test. However, it was not possible to identify any statistically reliable dissociation of health problems on the basis of the two groups represented by these clusters.

To address the second research question, first the incidences of above average (scale point 4) and severe (point 5) musculoskeletal pain across the body (including head, spine, and upper limbs) as well as the incidences of psychosomatic symptoms (see Kreutz *et al.* submitted) were calculated per individual. Of the 246 individuals who completed the relevant questionnaires in full, 84 (34.1%) reported themselves to be free of any such symptoms. A further 84 (34.1%) reported at least one incidence of both musculoskeletal pain and at least one non-musculoskeletal symptom. The remaining participants formed two approximately equal groups: 34 individuals (13.8%)

Table 2. Subsets from posthoc comparisons of means representing influences of health problems on standard of practice and performance.

		Subsets for alpha=0.05			
		Practice		*Performance*	
	n	*1*	*2*	*1*	*2*
No problems	84	1.60		1.49	
Musculoskeletal only	44		2.21		2.18
Non-musculoskeletal only	34		2.25		2.36
MS and NMS combined	84		2.69		2.43

Note. A 5-point rating scale was used, from 1 (no interference) to 5 (strong interference) with practice.

reported at least one incidence of musculoskeletal pain and 44 (17.9%) reported at least one incidence of a non-musculoskeletal problem.

To assess any influences of health issues represented in these groups on perceived practice and performance quality, univariate ANOVA procedures were performed. Results were similar for the five scales representing practice and performance quality. Significant main effects were observed for each of the scales, all $F(3,242)>10.08$, $p<0.001$. Posthoc comparisons using Scheffe's test suggested two homogeneous groups (see Table 2).

DISCUSSION

This study follows up investigations of healthy lifestyles and health problems in music students from two UK conservatoires (Kreutz *et al.* in press, submitted). Two questions were raised. First, it was asked whether subgroups of students adhering to different levels of healthy behaviors were also attracted to different health problems, and second, whether incidences of health problems were associated with self-reported measures of practice and performance quality.

Two subgroups reporting low and high adherence to healthy lifestyles were identified. The smaller, high-adherence group may be characterized by a linear positive shift of judgments of healthy behaviors as compared to the low-adherence group. Thus, the analysis fails to identify groups of individuals that might attribute different *relative* weights to their healthy lifestyles. There were consistent mean differences across all subscales, indicating that the two groups were very similar in their *relative* rather than *absolute* assessments of components of self-reported healthy behaviors. The absolute differences in these groups may thus indicate difficulties reporting actual levels of healthy lifestyles but at least suggest a consistent use of the measurement instrument. Despite the large variances of individual levels of healthy lifestyles, music students appear to be a surprisingly homogeneous group in this respect.

The second finding is the combination of musculoskeletal and non-musculoskeletal health issues that most strongly influenced self-reported practice and performance quality. Although not reported in this study, it may be noted that the presence of MS and/or NMS issues to some extent also affected psychological variables (data are not reported here due to space limitations). The present results suggest that the accumulation of health issues does seem to impact on music practice and performance.

Limitations of the study should be noted with respect to the reliance on self-reports only. Moreover, no conclusions can be drawn as to whether the observed data generalize across other student populations. Therefore, future investigations should advocate a systems level approach to musicians' healthy lifestyles by using objective measures that should reflect the physical and mental needs of a highly demanding profession.

Acknowledgments

I am indebted to my colleagues Jane Ginsborg and Aaron Williamon and to the participants of the survey.

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References

Kreutz G., Ginsborg J., and Williamon A. (in press). Health-promoting behaviours of conservatoire students. *Psychology of Music*.

Kreutz G., Ginsborg J., and Williamon A. (submitted). Health problems and health-promoting behaviours of music students.

Walker S. Sechrist K., and Pender N. (1987). The Health-Promoting Lifestyle Profile: Development and psychometric characteristics. *Nursing Research*, *36*, pp. 76-81.

Wynn Parry C. B. (2004). Managing the physical demands of musical performance. In A. Williamon (ed.), *Musical Excellence* (pp. 41-60). Oxford: Oxford University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Just in Time as a scientific interface between rhythm composition and performance

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In apparent contradiction to the commonly addressed "naturalness" of rhythm and its intrinsic relation with humans, the study of this music parameter has received only modest attention from the Western theory of music, as compared with the study of pitch issues (in the form of melody and harmony). Throughout the history of Western music, composers and performers developed the articulations of temporal structure to a remarkably high level of imaginative skill and proficiency in matters effecting phrase lengths, rhythmic combinations, and the architectonics of music and structural proportions. From a rhythmic point of view, however, these practical achievements were rarely matched or accompanied by theoretical consideration of the problems they faced or the solutions at which they arrived: rhythm and meter were generally seen as subordinate to pitch structure. Using the rhythmic theoretical tool *Just in Time*, this paper presents a rhythmic analysis of the first part of the A section of the jazz tune *After You've Gone* by Creamer e Layton, as well as Benny Goodman's improvisation in the same section. Within the context of composition/notation (original tune), and improvisation/performance (Goodman's version), the proposed rhythmic model provides useful insights about some of the processes involved in rhythmic composition and performance.

Keywords: theory; analysis; perception; rhythm; meter

One of the aims of the theoretical construct *Just in Time* (Lopes 2003) was to develop a way in which a critical "voice" can also be given to the so-called "musical surface." As opposed to pitch relationships, which show up at all levels of conventional music theory, durational relationships (rhythm and meter) are usually seen as confined to the musical surface, and thus as lacking critical value; not, in short, a concern of the connoisseur. This (traditional) positioning of the durational parameters of music is well demonstrated in the work of Cooper and Meyer (1960), Yeston (1976), and Lerdhal and Jackendoff (1983), just to name a few. It is, then, exactly the perceptual qualities of the music surface, of which rhythm and meter are among the most important, that should be the concern of a music theory aiming to do justice to the listener: a music theory, therefore, with a more contemporary (i.e. inclusive) stance.

MAIN CONTRIBUTION

Many empirical studies on the perception of music, such as the ones conducted by Drake *et al.* (1991) and Drake and Botte (1993), where the perceptual significance of accent structures derived entirely from the durational parameters of music is compared to those derived from pitch, reveal a minor but systematic difference favoring the perceptual importance of duration-related parameters. In line with this, *Just in Time* created a systematic rhythm and meter model that is closely related to the perception of music, since it was based on empirical experiments. Such a model can then be used to predict the relative salience and perceptual qualities (e.g. kinesis) of different durational patterns.

***Just in Time* revisited**

The following is a *Just in Time* analysis of a rhythmic sequence; it is assumed that a successful inference of the notated rhythm and meter has taken place (so that the metrical framework is known from the start). As shown in Figure 1, the quarter-note at 1:1 is an extremely salient pulse: not only it is stable because of its strong metrical placement, but also it is a long pulse (agogic accentuation), and further accentuated by the preceding two small pulses (rhythm cell accentuation). The rhythm cell on the second beat is isochronous and does not accentuate the following pulse 1:3 because it is longer than the ensuing eighth-notes.

The internal organization of the rhythm cell at 1:3 accentuates the eighth-note on the upbeat. Although similar to that at 1:2, the rhythm cell at 1:4 receives an analytical notation because it precedes a longer pulse, which it further accentuates. In this way, and similarly to that at 1:1, the quarter-note at 2:1 is an extremely salient pulse. In measure two, the second, third, and fourth beats create a rhythm motif, as notated, with the short pulses in beats two and three further accentuating the quarter-note at 2:4; this too becomes an extremely salient pulse, as indeed does the half-note at 3:1, the longest duration in the sequence.

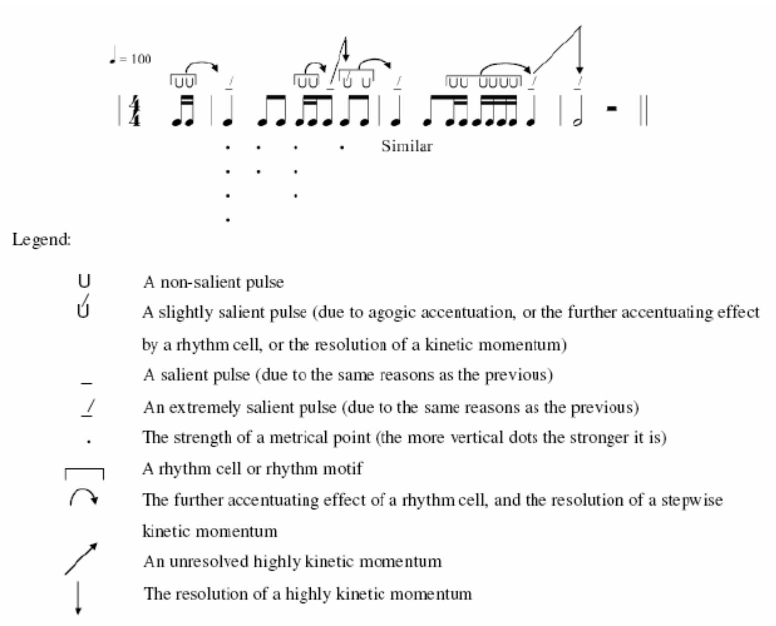

Figure 1. A *Just in Time* rhythmic analysis.

While these are the primary saliences, there are others, such as the eighth-notes at 1:2 and 2:2. These are, after all, long as compared to the surrounding sixteenth-notes, and they are also placed on the first part of the second beat of a quaternary meter. As the meter stratum notation indicates, this metrical point is the third strongest of the sixteen points which comprise the lowest realized metrical level in this sequence (i.e. the eighth-note level). The eighth-note at the first part of 1:4 will also receive some extra accentuation due to the resolution of a high kinetic momentum.

Considering the quality of kinesis which is conveyed by this sequence, following the stable quarter-note on 1:1, we can now better assess the isochronous rhythm cell at 1:2 : it is part of an increase in pulse density which culminates in the accentuation of the second eighth-note of 1:3. This pulse density increase (two eighths plus two sixteenths) also creates an increase of kinesis.

The second eighth-note of 1:3 also releases kinesis because it is a salient pulse on a weak metrical point. Unlike the stepwise kinesis resulting from pulse density, this type of perceptual motion implies a far-reaching release of kinesis. Because this highly kinetic momentum causes great instability, it needs resolution, which is accomplished through the charging of the next relatively strong metrical point. The expected resolution of this highly kinetic momentum further accentuates the eighth-note on 1:4. Implying stepwise kinesis, the rhythm cell at 1:4 in turn accentuates 2:1. If the sequence is being heard for the first time, then it will be only here, following this highly kinetic momentum, that the metrical context will be stabilized. Further stepwise kinetic potential starts to be realized at 2:2, which culminates in the extreme salience of 2:4, releasing an even greater amount of kinesis. As before, this momentum is resolved at 3:1, and hence further accentuating the quarter-note and stabilizing the metrical context.

In short, the rhythmic structure of the sequence makes some pulses more salient or kinetic than others, and hence more prominent to the listener. In this way, the qualities resulting from a rhythmic construct can be measured against that resulting from other musical parameters. By providing a means to assess rhythmic pulse salience, the proposed rhythmic model becomes a specialized tool within an overall analytical approach.

The bridge between rhythm composition and performance

We will now proceed to evaluate in which ways *Just in Time* is able to provide insights into the relation between rhythm composition and performance. For this, we will analyze the first few bars of the A section of the Jazz tune *After You've Gone*' as improvised by Benny Goodman.

The solo starts at the break. Goodman's choice to start the solo on the third beat of the quaternary measure, which is only the second strongest beat in the measure, shows a way to infer as early as possible some kinetic qualities. One should also mention that the first four beats present the so-called jazz groove: shorter notes on the second and fourth beats. The choice of this construction is well in line with one of the main composition principles: the introduction as early as possible of the main theme. The solo follows with an eighth-note rhythm motif during one and a half measures, stabilizing the kinetic momentum initiated. The last measure of the break introduces rhythm cells on the first and second beats containing two sixteenth-notes on the beat's weak part, raising the perception of kinesis and accentuating the following beats. In the second beat, this rhythm cell is followed by a rest which abruptly stops the kinesis and its resolution; in this way, Goodman clearly states the end of the break and the beginning of a new section.

This section is efficiently inferred through the return of the jazz groove on the fourth beat of the last measure of the break. By preceding a long note on

Figure 2. The solo.

the first beat of the first measure of the theme, these eighth-notes also accentuate the half-note on the first beat, clearly initiating a new structure. The first four measures present a dual structure, in which long notes on the first and third measures correspond to a group of notes that almost fill measures two and four. This structure is relevant in many ways: from the highly kinesis point of view that is expected from this music genre, the placement of only one note on the most stable point in the measure is counterbalanced by the following highly kinetic measure. Also, the perception of the metric off-phase that exists between the original melody and the solo tends to raise the kinesis of this section. Although this music genre is highly kinetic, it exists over a clear metrical frame. Therefore, as in the break, Goodman rhythmically refers to this idea: a kinetic genre (i.e. motion measures two and four) over a controlled basis (the half-notes on measures one and three). Interesting to notice is that under the small harmonic motion of these measures, the design of the jazz groove at a hyper-metrical level becomes clear: less notes on the first and third measures, more notes on second and fourth measures.

IMPLICATIONS

Although in a brief way, we hope to have shown ways in which *Just in Time* relates to musical listening. As well as generating kinetic effects, rhythmic saliences can act as yardsticks in the listening process, helping to construct a cognitive framework within which moment-to-moment perceptions are organized. Because this model promotes a systematic understanding of the means to produce, underline, or contradict pulse salience and kinesis, it also has something to offer to the composer, performer, improviser, and music teacher.

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References

Cooper G. and Meyer L. (1960). *The Rhythmic Structure of Music*. Chicago: University of Chicago Press.

Drake C., Dowling J., and Palmer C. (1991). Accent structures in the reproduction of simple tunes by children and adult pianists. *Music Perception,* 8, pp. 315-334.

Drake C. and Botte M. C. (1993). Tempo sensitivity in auditory sequences: Evidence for a multiple-look model. *Perception and Psychophysics, 54*, pp. 277-286.

Lerdahl F. and Jackendoff R. (1983). *A Generative Theory of Tonal Music*. Cambridge, Massachusetts, USA: MIT Press.

Lopes E. (2003). *Just in Time: Towards a Theory of Rhythm and Metre*. Unpublished doctoral thesis, University of Southampton.

Yeston M. (1976). *The Stratification of Musical Rhythm*. New Haven, Connecticut, USA: Yale University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Science meets art: The body and its role in "shaping" piano music

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This paper seeks to show that the body of the pianist may have a role to play in "shaping" musical works for performance. This view is now supported in musical academic circles who wish to promote a more interdisciplinary approach to performance. The argument is presented in three stages as follows. First, "Human Movement Systems" explores how order emerges in such a complex system as the body. Second, "Shaping Musical Performance" examines the most important conceptual challenge a pianist can face, which is how to shape a musical work for performance; a simple "performative" analysis is devised which exposes the structural elements of the music which support its shape. In the final stage, both approaches are shown to converge and complete the performative analysis as a design which may be used during the preparation of a musical work for performance.

Keywords: piano performance; embodiment; kinetic chain theory; performative analysis; melodic shaping

The general attitude of pianists toward a scientific investigation of their art is most regrettable—the "whys" and the "wherefores" do not concern them. Thus wrote Otto Ortman in 1929. Today, Ortmann would find that there has in general been little change. Performers and pedagogues alike still largely ignore the role of the body in performance, preferring the traditional approach to piano teaching with its emphasis on correct finger usage.

Thus, this paper seeks to show that piano performance may be enhanced by examining the role of the body in "shaping" the music for performance. As yet, this is an unexplored area of piano performance which reflects some of the most important trends in the study of musical performance, such as the relationship between performance and analysis on the one hand, and physical anthropology and the human movement sciences on the other. "Human

Movement Systems" is an account of recent research which shows how movement systems function in humans and how they synchronize in such a complex system as the body which is continually undergoing change during piano performance. For example, the "kinetic chain theory," so described because of its emphasis on the processes of coordination and control in the human movement system is viewed here as a viable framework by which the movements of the performer may be organized in piano performance. In "Shaping Musical Performance," a simple "performative" analysis is given as an example of a way in which structural elements of the music which support the melodic "shape" can be exposed. The final stage is "The Performance." Here, the analysis is completed by showing that aspects of the music which support the melodic shape, such as the accents and dynamics, can function as musical goals toward which the performer directs the movements of his/her body.

MAIN CONTRIBUTION

Human movement systems in piano performance

Until recently, detailed analysis of the anatomical structure of the body has been the main focus of leading researchers. Now, there is a shift in contemporary research from structure to function. This means that some researchers are seeking to understand the body by examining not just the anatomical structure of the bones and muscles, but their function in relation to movement. There are three main areas of the body which function in piano performance. They are the shoulder complex, the hand, and the torso. Each is discussed briefly below.

The shoulder complex comprises the scapula, the upper arm (the *humerus*), and the collar bone. The scapula and the collarbone form the foundation upon which the upper arm moves. Kinesiologists Tyldersley and Grieve (1996) describe the function of the shoulder complex in a way which is apposite for the pianist: "Acting like the cab of a crane, the shoulder positions the hand in the same way as the jib of a crane places its load." This means that the hand may be positioned on and around the keyboard according to the requirements of the music.

The function of the hand is described by Marzke (1994) from an anthropological point of view. She says that our earliest primate ancestors had pentadactyle (five-finger) hands with a divergent thumb, but the design was sacrificed when our more recent ape-like ancestors developed longer fingers and independently controlled movements of the index finger and opposable thumb. In piano performance, this means that not only are the fingers of the hand able to flex around the shape of a chord while the thumb grasps the bottom note of the chord in an opposing movement towards the other fingers, but individual fingers can be trained to flex against the key surface without the thumb opposing the movement, as in scale passages.

There is very little reference to the function of the torso in piano performance. However, insights into the function of the spine of the torso may be gleaned from another area of research which is cybernetics (i.e. the study of automatic control systems in living things). For example, Gracovetsky (1998) says that when analyzing our evolution from fish-like ancestors, we seem to have lost touch with the fact that the spine and surrounding tissue of a fish are the primary engine which the animal uses for locomotion. He concludes from this observation that the human "spine behaves like an engine driving the pelvis, with the legs following and amplifying its motion." Thus, it may not be unreasonable to suggest that if the function of the spinal engine is to drive the pelvis, which in turn amplifies the movement of the legs, this may equally be said to be the case for the movement of the arms in piano performance.

While the preceding description of the body partially clarifies the function of the three main areas identified above, it does not address the problem that in piano performance synchronicity of movement between the shoulder complex, the hand, and the torso is essential. However, recent research into human movement in physical anthropology and the human movement sciences all point to a better understanding of how the movements of the shoulder complex, the hand, and the torso may be synchronized in piano performance.

Of the synchronous relationship between the shoulder complex and the hand, Marzke (1994) writes that our:

> early hominid ancestors dwelt in the trees and the development of their synchronous ability to position the upper arm and perform grasping actions with the hand for food were essential to their survival and success. By the time they left the trees to dwell on the ground, this ability to position the upper arm and perform grasping actions with the hand was as developed as ours is today.

Thus, in piano performance the shoulder complex positions the upper arm and enables the hand to make appropriate pre-shaping movements according to the demands of the music. Forces are then applied by the shoulder complex and modulated to maintain a stable grasp of the piano keys.

Synchronizing the movements of the torso with the shoulder complex and the hand may well be explained by the research of sports scientists Glazier *et al.* (2003), who suggest that "the dynamical systems theory is a viable framework for modeling athletic performance owing to its emphasis on processes of coordination and control in human movement systems." A key theoretical concept is the kinetic chain, although they admit "that this has yet to be fully explored." They define this phenomenon as a "proximal-to-distal linkage system through which the energy and momentum (as in a wave motion) are transferred sequentially, achieving maximum magnitude in the terminal segment." This means that the build-up of velocity in the segments with high moments of inertia move first, with the smaller segments involving less mass moving later and with higher velocities. Such a sequencing allows proximally located muscles (in the torso) to use their capacity to the full to do work in contributing to the continued acceleration of the most distal segments, which in piano performance would be the hand.

"Shaping" musical performance

If a performer makes claims for melodic shaping, then a contingent interpretive question must be: which analytical assumptions are going to inform these decisions? In Figure 1, the assumption is that accents (such as >) and dynamic markings (such as *ff*, *sfz*, and *sff*) shape the melodic line.

Figure 1 is a simple performative analysis which the pianist may easily devise during the preparation of *Em Um Berço Encantando* (1918) by Villa Lobos for performance. Bars 10-16 are a complete melodic phrase. It is reproduced deliberately on one line (see Level 1). The intention is: (i) to see the shape of the phrase as a whole, when it is not broken by the printed notation wrapping round onto the next line and (ii) to note the accents and dynamic markings which are deemed here to support the melodic phrase. Below this, Level 2 shows a reproduction of those same accents and dynamic markings in the upper-most staff at Level 1. They are positioned directly below the accents and dynamic markings in the score. The reason for this is revealed below in the "The Performance."

The Performance

The final stage of this paper is to demonstrate a convergence of both approaches described above. Thus, Level 3 (see Figure 1) completes the performative analysis. It depicts the trajectory of the performer's body as the wave motion directs it toward each of the musical goals. The wave motion is initiated by a contraction of the deep abdominal muscles in the torso and

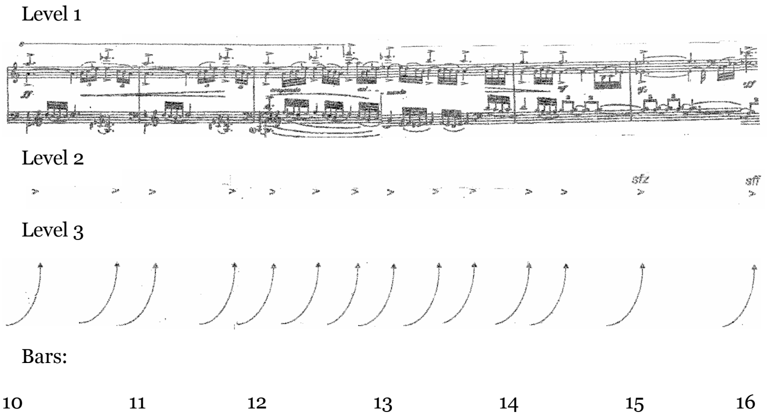

Figure 1. A performative analysis of bars 10-16 of *Em Um Berco Encantando* by Villa-Lobos (1918). The time signature is 9/8. Level 1: Upper staff shows the accents >, *ff*, *sfz*, and *sff* which provide the structure for the entire melodic phrase. Level 2: Melodic goals—accents >, *ff*, *sfz*, and *sff* are reproduced from the score above. Level 3: The trajectory of the performers' body as the wave motion directs it toward the musical goal.

transferred sequentially. It passes through the torso, the shoulder complex, and the hand with increasing velocity, thus allowing the grasping function of the latter to be fulfilled before the energy is finally transferred to the key bed. Once the wave motion has been initiated and the performer's body has reached the musical target, the lower abdominal muscles may relax before repeating the same procedure toward the next musical goal. It should be pointed out, however, that the velocity of the wave motion will vary since it is dependant upon the intensity of the musical goal. This can only be determined by informed intuition on the part of the performer.

CONCLUSION

The aim of this paper has been to examine the role of the performer's body in shaping the music. This is an interdisciplinary approach which has required an examination of the research of writers in other fields such as physical anthropology and the human movement sciences, as well as exploring recent innovations to traditional analytical procedures in areas which have resisted systematization, such as shape.

As a result, I have been able to show: first, that the movements of the shoulder complex, the hand, and the torso may be synchronized by a wave motion in piano performance; second, a simple performative analysis may be easily constructed by the performer, which exposes the structural elements which shape the music. Finally, I have sought to show that the structural elements of the music can function as the musical goals to which the movements of the performer's body are directed during the performance, thereby deliberately engaging the body of the performer in the act of music making.

IMPLICATIONS

Overuse of the hand is prevalent in piano performance. This often leads to tendonitis, which is a condition caused by an inflammation of the synovial sheaths which surround the tendons of the muscle. Force should only be applied by the shoulder complex as the muscles of the hand flex (rather than push) the fingers in a grasping action against the piano keys.

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References

Bennett S. (2003). Comment on dynamical systems theory: A framework for performance-orientated sports biomechanics research. *Sportscience, 7*, sportsci.org/jour/03/sjb.htm.

Glazier P., Davids K., and Bartlett B. (2003). Dynamical systems theory: A relevant framework for performance-oriented sports biomechanics research. *Sportscience, 7,* sportsci.org/jour/03/sjb.htm.

Lees A. and Davids K. (2002). Co-ordination and control of kicking in soccer. In K. Davids (ed.), *Interceptive Actions in Sport: Information and Movement* (pp. 273-287). London: Routledge.

Marzke M. (1994). Evolution. In K. M. B. Bennett and U. Castiello (eds.), *Insights into the Reach to Grasp Movement: Advances in Psychology* (pp. 19-36). Amsterdam: Elsevier.

Ortmann O. (1929). *The Physiological Mechanics of Piano Technique*. New York: Kegan, Trench, Trubner and Co.

Tyldesley B. and Grieve J. (1990) *Muscles, Nerves, and Movement: Kinesiology in Daily Living*. Oxford: Blackwell Science Pub.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Control of affective content in music production

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Music is a ubiquitous media in our lives, used in many contexts. The possibility to select appropriate affective music can be helpful to adapt music to our emotional interest. Our work intends to design a system to control affective content in music production. This is done by taking into account a knowledge base with mappings between affective states (e.g. happiness, sadness) and music features (e.g. rhythm, melody). The knowledge base is grounded on background knowledge from music psychology. Our system starts with the reception of an emotional description specified by the user. Next, mappings are selected from the knowledge base, according to the emotional description. Music is retrieved from a music base (recorded sound and MIDI files) according to similarity metrics between music features (of mappings and music base). Afterward, selected music can be subject to transforming, sequencing and remixing algorithms, and then played. The inclusion of third party composition software is also envisaged. To assess the system, listener emotional state can be analyzed using psychophysiological or self-report measures.

Keywords: affective music; music production; emotions and music; music psychology; music features manipulation

Music has been widely accepted as one of the languages of emotions. The possibility to select appropriate affective music can be helpful to adapt music to our emotional interest. Nevertheless, only recently scientists have tried to quantify and explain how music influences our emotional states. According to Scherer (1984), emotions may be conceived as consisting of various components: cognitive appraisal, physiological activation, motor expression, behavior intentions, and subjective feeling. Emotional states can be described as particular configurations of these components. For a long time, cognitive sciences have been studying the foundations of emotions. More recently, computational models have also been proposed and are being applied in several domains (e.g. music, dance, and cinema).

There are distinct approaches and techniques used to generate music with appropriate affective content. Starting from results of previous work (Schubert 1999), Livingstone and Brown (2005) established relations between music features and emotions. Both emotions and a set of music-emotion structural rules were represented in a 2-Dimensional Emotion Space with an octal form. A rule-based architecture was designed to affect the perceived emotions of music, by modifying the musical structure. Livingstone *et al.* (2006) made a symbolic music performance engine that could adapt score reproduction with the audience's emotions. This engine was grounded on a list of performative and structural features that could be changed and on their emotional effect. For instance, tempo, mode, and loudness are structural parameters, and tempo variation, melody accent, and note accent are performative parameters.

A MIDI-based software named REMUPP (Relations between Musical Parameters and Perceived Properties) was designed to study aspects of musical experience (Wingstedt *et al.* 2005). This system allowed for the real-time manipulation of musical parameters like tonality, mode, tempo, and instrumentation. For instance, articulation is changed by altering the length of notes and register by altering the pitch of notes. This system has a music player that receives music examples and musical parameters. Music examples are composed by MIDI data and a set of properties. Musical parameters can be used to control the sequencer, to control synthesizers, or to employ filters and effects on MIDI stream. Winter (2005) built a real-time application to control structural factors of a composition. Models of musical communication of emotions were reviewed to get an insight of what musical features are relevant to express emotions. Pre-composed musical scores were manipulated through the application of rules. These rules have some control values for different musical features: mode, instrumentation, rhythm, and harmony.

In recent years many research areas have been working to reduce the semantic gap that exists between music features and human cognition. From this research, some work has established mappings between musical features and emotions. Our work is intended to design a system to produce affective music by taking into account a knowledge base with mappings between emotions and music features. This work is being developed in two stages. Firstly, studies of the relations between emotions and musical features are examined to select mappings useful in our computational context. Secondly, a computer system that uses these mappings to produce affective music is designed, implemented, and assessed.

MAIN CONTRIBUTION

From a general standpoint, this work intends to contribute to the fields of music psychology and computer music. Our multidisciplinary review (and selection) of mappings between emotions and music features can contribute to a systematized scientific research in music psychology. Both structural (e.g. harmonic mode and overall pitch) and performing features (e.g. melodic accent and beat accent) can be controlled (selected and transformed) in the production of music with the intent to generate appropriate affective music. Thus, our system can be used by musicians as an affective music production tool or as an autonomous affective DJ-like application.

Computational Approach

Our computational approach deals with the problem of inducing emotions with music. A brief overview of our approach is presented in Figure 1. The input is the description of the emotional experience that the system is intended to induce in the listener. A Knowledge Base with mappings between emotions (e.g. calm, anger, sadness, happiness, and fear) and musical features (e.g. harmony, melody, rhythm, dynamics, tempo, texture, and loudness) allows the system to retrieve the more appropriate music from the music base. Then, music is played and the emotional state of the listener can be analyzed using psychophysiological and/or self-report measures. Results from these measures are then subject to statistical analysis methods.

Now we will concentrate our attentions in the description of the module of music production, which is responsible for the generation, sequencing, remixing, and synthesis of music. This module uses algorithms to manipulate audio and MIDI. Sound effects usually used by DJs may be used to manipulate music to induce specific emotions. Equalization may be used to change the frequency envelope of a sound by applying filters. For instance, high-pass filters are used by DJs to reduce low frequencies (e.g. drums) to promote moments of relaxation. Other effects like 3D, chorus, diffusion, distortion, echo, flanging, phasing, and reverberation are also used to manipulate audio. More information about the role of these effects on the emotional response of audiences can be found in Barrington *et al.* (2006). There are many algorithms to manipulate MIDI in ways that may be used to adapt musical features to the intended emotional effects over the audience. Phrase expression, chord asynchrony, melody dynamics, ADSR envelope,

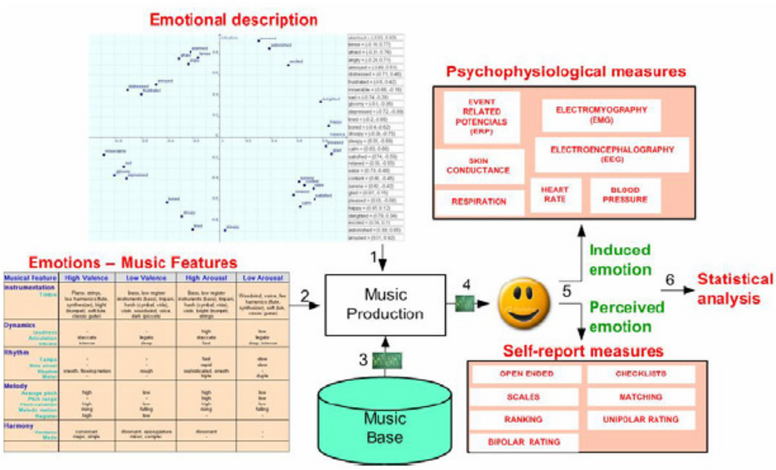

Figure 1. A computational approach for inducing emotions with music. (See full color version at www.performancescience.org.)

humanizing functions, tonality, mode, harmonic and rhythmic complexity, register, instrumentation, articulation, tempo, and perception parameters (roughness) are some of the features that can be manipulated in the MIDI plane. The following works can be consulted to obtain information about algorithms used to manipulate MIDI files: Livingstone *et al.* (2006), Wingstedt *et al.* (2005), Winter (2005), and D'Inca and Mion (2005).

The manipulation and sequencing of MP3 files and/or MIDI files is done at this stage. The way this is done is similar to the approach followed in REMUPP (Wingstedt *et al.* 2005). Our work considers music examples represented in standard MIDI format (MID/MIDI) and MP3 format. These examples are selected from the music base in the previous stage. Musical parameters are selected from the knowledge base during the knowledge selection stage. Some algorithms for music manipulation of musical properties (e.g. sound effects and synthesis) and the way music examples are sequenced will be implemented/adapted. Figure 2 presents the main processes involved in this module, which is similar to the architecture of REMUPP's music player.

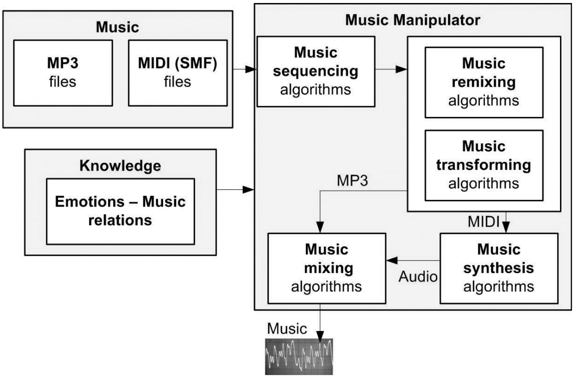

Figure 2. Module of music production.

Techniques and Algorithms

The Knowledge Base (KB) is like a white box module with mappings between emotions and musical features. This means that all represented mappings are always visible. This option derives from the fact that this KB can be used in the future by music psychologists and therapists. Both case-based and rule-based techniques are known to be adequate for this kind of representation. Semantic networks and frame/analogy-based systems can also be helpful. Some algorithms will be developed: music transformation, music sequencing, and music remixing. Others will be adapted from third party software/algorithms: music composition, music selection (e.g. energy, timbre), music mosaicing (automatic remixing), and music synthesis. All these algorithms take into account the control of music affective content.

IMPLICATIONS

This research reviews affective computing and music psychology work relevant to the design of a computational model of automatic music production according to an emotional description. We intend to develop a computational systematization of relations between emotions and music which can contribute to a high affective control in the selection and transformation of both structural (e.g. harmonic mode) and performing features (e.g. beat accent).

We intend to tune our system with users to promote a reliable induction and expression of emotions by using music. This way, our system can be applied in areas that intend to produce music given an emotional input. It may assume the role of a tunable support tool for scientific research in music psychology. It may be applied in the production of soundtracks for entertainment activities. It may also be useful in music therapy as a way of emotional, cognitive, and physical healing. Musicians can also benefit from this system as an affective music production tool or as an autonomous affective DJ-like application.

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References

Barrington L., Lyons M. J., Diegmann D., and Abe S. (2006). Ambient display using musical effects. *International Conference on Intelligent User Interfaces*, *11*, pp. 372–374. New York: ACM Press.

D'Inca G. and Mion L. (2006). Expressive audio synthesis: From performances to sounds. Paper presented at the *International Conference on Auditory Display*, London, UK.

Livingstone S. and Brown A. (2005). Dynamic response: Real-time adaptation for music emotion. *Australasian Conference on Interactive Entertainment*, *2*, pp. 105–111.

Livingstone S. R., Muhlberger R., and Brown A. R. (2006). Influencing perceived musical emotions: The importance of performative and structural aspects in a rule system. *Music as Human Communication: An HCSNet Workshop on the Science of Music Perception, Performance, and Cognition*, Sydney, Australia.

Scherer K. (1984). On the nature and function of emotion: A component process approach. In Klaus R. Scherer, Paul Ekman, *Approaches to Emotion* (pp. 293–317). Hillsdale, New Jersey, USA: Erlbaum,.

Schubert E. (1999). *Measurement and Time Series Analysis of Emotion in Music*. Unpublished doctoral thesis, University of New South Wales.

Wingstedt J., Liljedahl M., Lindberg S., and Berg J. (2005). REMUPP: An interactive tool for investigating musical properties and relations. *New Interfaces for Musical Expression, 5*, pp. 232–235.

Winter R. (2005). Interactive Music: Compositional Techniques for Communicating different Emotional Qualities. Unpublished masters dissertation, University of York.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Learning to be…singing: A choral music education program

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The purpose of this paper is to share the success story of a choral music education program for children and youth, to discuss its benefits to members, and to relate the results to current best practice and research. Beyond its musical and artistic purposes, the Coral Polifónico Juvenil intended to promote on its members, aged between 10 and 16 years, the development of personal, interpersonal, and social skills. The most important findings are that the musical participation in the choral activity has had very positive impacts on pupil's perceptions, attitudes and beliefs toward music in general and toward choral music participation at school. The pupils felt important, happy, and more useful as well as appreciated by their colleagues at school, by their families, and their communities. They expressed a sense of responsibility and conscientiousness, with notions of values of persistency and perseverance. Regarding interpersonal benefits, they acknowledged in these activities an excellent chance to relate themselves with others and to enlarge their cultural and musical experiences. The pupils recognized that their participation in the choral activity provided them with opportunities to develop their personal, social, and cultural skills and knowledge, as well as providing them with other professional perspectives.

Keywords: extracurricular musical activities; choral environment; music education; self-perceptions; attitudes

This study reports on an academic year case study of the impact of a choral music education program on children and youth at the College João de Barros, Meirinhas, a rural town in Portugal. The aim, as Hoz (1985, p. 43) says of case studies, was to provide “a circumscriptive scrutiny of opinions” through a “scientific method which analyses reality” on its variables and relationships which surrounds it.

Research has shown that classes that require active participation as a chorus and are presented by music educators with the aim of achieving mastery of musical skills and knowledge has failed to attract a significant number of participants from the school population (Nierman and Weak 1997). Usually the participation in choral music programs is somewhat small at secondary schools when compared to participation in elementary schools (Mizener 1993).

The Coral Polifónico Juvenil of the João de Barros College was founded in September, 2002, and integrated into the extracurricular activities at school. The choir started with 60 students aged between 9 and 16 years old, with repertoire including Gregorian Chant, Portuguese popular music, as well as a selection from Mozart, César Franck, Handel, and Fernando Lopes Graça.

Since the beginning, the choir has had many public presentations with and without instrumental accompaniment, mainly during religious dates. Furthermore, the choir has been playing an important role in several school initiatives as well as providing cultural and generational encounters through participation in concerts in social institutions throughout the country.

Beyond its musical and artistic purposes, the Coral Polifónico Juvenil intended to promote on its members the development of personal, interpersonal, and social skills. Students’ awareness of their skills and self-perceptions are carefully addressed during choir activities as they relate to the notion of “self-esteem” (Freitas 2003).

Research also indicates that taking part in musical activities at school can affect children’s identification with school music lessons, and that their identification with school in general can be increased. In particular, children who participate in extra-curricular musical activities can experience a higher sense of identification with school as they move from primary to secondary school than children who do not. Other studies have supported this view by investigating the direct effects of children’s participation in those activities, showing that they can help to raise children’s future aspirations (Denny 2007).

This study intends to examine the impact of participating in a choral music education program in extracurricular settings on participant’s attitudes, self-perceptions, and beliefs about music and themselves. What are pupil’s perceptions regarding their participation in the choral activity? What are pupil’s attitudes and beliefs with respect to choral music at school?

METHOD

Participants

All 50 participants in the study were students from the Portuguese secondary school Colégio João de Barros in Pombal, who took regular part in the choral activity on a facultative basis. All students lived near school and were from social, artistic, and cultural low or medium classes. Participants were aged between 10 and 16 years old, of which 42% were boys and 58% girls. The majority were in grade 9, representing 40% of the participants, followed by 24% in grade 7, 14% in grades 6 and 8, and 8% in grade 5. The soprano voice had 46% of the participants, contralto 32%, and tenors 22%.

Materials

The questionnaire aimed to obtain a detailed description of participants' attitudes and beliefs about choral music participation. The questionnaire included two main types of measures: participants' perceptions regarding their participation in the choral activity; and participants' attitudes and beliefs with respect to choral music in school. The questionnaire used closed questions, dichotomous questions, rating scales and opened questions.

Procedure

Before the questionnaire was administered to participants, a validate study was conducted by submitting it to the judgment of three experts (Oppenheim 1992), who presented their opinions in order to increase the reliability, validity, and practicability of the questionnaire. The researchers distributed the questionnaire to all participants with a maximum response level.

RESULTS

Participant responses to the 11 items about participating in choir activities showed that 86% felt important and adult in moderate to high levels. Most students, 88%, shared a feeling of freedom and felt a high degree of autonomy, representing 90% in moderate to high levels. Perhaps not surprisingly, a lower number of students, 64%, mentioned the existence of amusing or entertaining moments during choral activity, possibly due to the different students ages involved in the choir in addition to their general level of adulthood beliefs. All students recognized in the choir activity a very good or excellent opportunity to learn singing very well, in addition to the development of memory skills. The increase in the levels of happiness and joy reported when participating in the choir activities are not surprising, showing a 98% in moderate to very high levels. Participating in this choir activity had implications on students' needs relating to attention and concentration levels during choir rehearsals as well as with their time scheduling and planning to study school subjects as reported by 98% of participants in a moderate to high level. The majority of participants, 92%, said that when participating in the choir activities their behaviour improved moderate to high levels.

Participant responses to the 5 items concerning opportunities provided by participation in the extracurricular choral activity show that the most valued, in high to very high levels by all students, are the chances to construct friendship and camaraderie, to help colleagues when needed, to exchange cultural and musical experiences with other choirs, and to learn and practice society rules of behaviour. Student responses indicated that 86% believed that choral activity provided them with moderate to very high levels of chances to establish new friendships with singers of other choirs.

Participants' opinions about their choir teacher indicated that 100% felt that he is their friend in a high to very high level. Concerning the repertoire sung in the choir, all students' responses showed that they enjoy it in a moderate to very high level. Nevertheless, when asked whether other people enjoyed listening to the choir repertoire, 90% answered yes in a moderate to very high level, 8% considered that public did not enjoy it at all.

All participants shared the opinion in a moderate to very high level that participating in the choir activity allowed students to learn how to use their voice in every day needs. Of the respondents, 8% considered that participating in the choir activity did not contribute to their cultural enrichment. All others reported in a moderate to very high level of perception concerning this contribution.

Of the participants, 68% reported at a moderate to high level that their motivation to study increased since they began participating in the choir activities. Only 10% considered that their motivation had increased very much while the other 22% responded mainly a little. Participants' responses to the importance of values of persistency and perseverance in projects in which one is involved illustrate. 98% think about those attitudes in a moderate to very high level of significance. Only 2%, representing the opinion of 1 student, consider it just a little important.

Students' responses to the 4 items about what they most enjoy when they sing with the choir clearly reveal that they found a high level of enjoyment in the trip and felt it was fundamental (64%), followed by the applauses (56%), and the singing moment (44%). All other students reported moderate to high levels of enjoyment regarding these items.

With a moderate level of enjoyment, 40% expressed that the moment they most preferred was the meal, perhaps due to the low economic and cultural status of most participants' families.

When asked about their opinion concerning the continuity of the choir (Coral Sinfónico Juvenil do CJB), 98% reported an affirmative answer which supports the importance and value that this extracurricular activity represents for participants. Only 78% explained their reasons for the previous response, which refer mainly to reasons previously reported in the questionnaire. Nonetheless, students stressed issues such as: the importance of providing new college students the same opportunity they had been provided by the existence of the choir; the therapeutic role of singing; the school promotion; how proud singing made their families, school, and teachers; a way of showing their skills besides those usually requested at school; and finally an excellent way of being with others and bringing people together.

When asked about their intent to participate later in life in musical activities, 68% reported an affirmative response. 38% of respondents elucidated those activities which included being a professional musician, a professional singer; continuing participating in choral groups, karaoke, and musical moments inside and outside school settings.

DISCUSSION

The main findings of this study indicate that participating in this choir in extracurricular settings had very high levels of impact on participant's attitudes, self-perceptions, and beliefs about choral music education programs. Participants felt important, proud, happy, and more useful and appreciated by their colleagues, families, and communities. They recognized that their participation in this activity provided them with opportunities to develop their personal, social, and cultural skills and knowledge, as well as providing them with other professional perspectives. They expressed a sense of responsibility and conscientiousness, with notions about the value of persistency and perseverance. Regarding interpersonal benefits, they acknowledged in the choral activity an excellent chance to relate themselves with others and to enlarge their cultural and musical experiences. Students reported that choral participation helped them to understand the importance of attitudes, like respect to others, tolerance, and the importance of applying it to practice in their lives, with themselves, and with society.

It would be interesting to expand this study by comparing results betweens students', teachers', and parents' perceptions as well as the influence of music teachers (and conductors) on the participants' attitudes, self-perception, and beliefs.

Through choral music participation, these students gradually developed and constructed their attitudes, self-perceptions, and beliefs about choral music education at school and outside school, about music participation, and about themselves. Through the development of a sense of awareness of their own skills, aptitudes, realizations, and maturity, choral music appears to be associated with a larger project, to the group in which it belongs (Vigotski 1977)—learning to be…singing.

Acknowledgments

The researchers would like to acknowledge the support given by the head teacher and pedagogical director of João de Barros College. Special thanks go to the students who participated in the choir, as well as in the study.

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References

Denny E. (2007). To what extent does participation in extracurricular music affect the future aspirations of 11– 12-year-olds? A small-scale investigation. *British Journal of Music Education*, *24*, pp. 99-115.

Freitas C. (2003). *A auto-estima e os consumos de álcool e tabaco em adolescentes escolarizados*. Unpublished masters thesis, Universidade de Trás-os-Montes e Alto Douro.

Hoz A. (1985). *Investigación Educativa: Dicionário de Ciências de la Educación*. Madrid: Anaya S.

Mizener C. (1993). Attitudes of children toward singing and choir participation and assessed singing skill. *Journal of Research in Music Education*, *41*, pp. 233-245.

Nierman G. and Veak M. (1997). Effect of selected recruiting strategies on beginning instrumentalists' participation decisions. *Journal of Research in Music Education*, *45*, pp. 380-389.

Vygotski L. (1977). *Psicologia e Pedagogia*. Lisboa: Estampa.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Analyzing performance interpretation: The bouncing ball

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In this paper, I propose an analytical method for recorded music that encourages connection between musical and physical movement. Through detailed analysis of the structure (both compositional and performed) of the music, the particularity of specific performance interpretations is captured by analogy with the motion of a bouncing ball. This is achieved by means of a mapping of the two elements of musical motion—"musical tension" and "rhythmic drive"—onto those of the bouncing ball motion: height and speed. This method provides not only a way of describing musical expression in a more systematic way but also a pedagogical tool to cultivate sensitivity to the rhythmic and expressive subtleties of music. A graphic notation system is presented along with ideas for the creation of a computer program to realize this bouncing ball animation.

Keywords: musical motion; musical tension; rhythmic drive; bouncing ball; performance interpretation

Traditionally, music analysis has focused predominantly on the analysis of the musical score with the aim of understanding mainly the compositional structure of music. While analysts normally expect a good analysis to reflect the way music is experienced, most analytical languages discourage involvement with the experiential or expressive content of music. This is not surprising given that musical scores omit expressive information that exists only as sound realized in performance. With the emergence, however, of recent computer software that makes possible the tracking of the precise manner in which the notes are performed in real time, music analysis has found new ground for exploration.

The present paper presents ideas for a new analytical method for recorded music that aims to capture aspects of musical experience or expression in general, and performance interpretation in particular. The

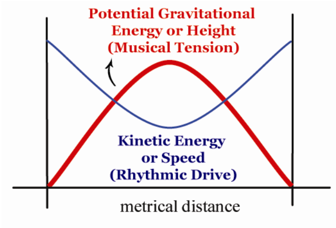

Figure 1. Graphic representation of the two components of (one cycle of) ball motion or musical motion. (See full color version at www.performancescience.org.)

analytical language used shifts the focus from a static representation of music, understood conceptually, to the more dynamic aspect of music as experienced in time through the whole body. More specifically, this language will describe musical experience in terms of the motion of a bouncing ball. With the ultimate goal of creating a computer program to generate bouncing ball animations to match someone's experience of music, I will present some ideas of how this modelling could be done and explain its pedagogical significance

MAIN CONTRIBUTION

The model is based on the simple observation that the experience of watching a bouncing ball is analogous to the experience of listening to regular beats in time. In addition to the attack point (the impact on the ground in the case of the ball motion or the musical accent in the case of musical motion) that ends one cycle and initiates another, we have two related parameters involved in this motion: potential gravitational energy, or the height of the ball, which corresponds to "musical tension" (MT) and kinetic energy, or the speed of the ball, which corresponds to "rhythmic drive" (RD). A single cycle of motion (either musical or ball motion) will be graphically represented as in Figure 1 where the red/thick and blue/thin lines correspond to the height/MT and the speed/RD respectively. Concrete examples that I will provide below will make this analogy more clear.

Having described the basic analogy between the ball and musical motion, I would like to point out that, in modelling real music examples, these two shaping forces will never relate in such a simple and predictable way. Given the complexity of the structure of the music that shapes musical motion, the *musical* bouncing ball will move in a more irregular, creative, and unpredictable way. In determining the precise way the two parameters of

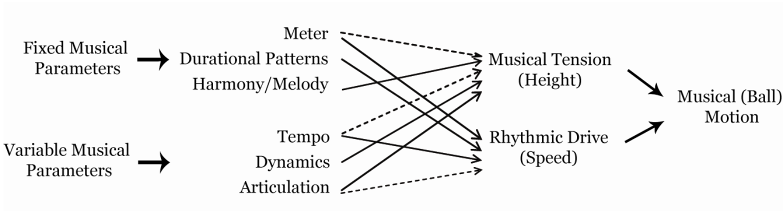

Figure 2. Contribution of *fixed* and *variable* musical parameters in shaping musical/ ball motion.

musical motion are shaped, one needs to consider the musical structure of a given piece. To simplify the complex way structure shapes musical experience, Figure 2 shows the general tendency of the various musical parameters to shape either MT or RD or both. (For a more specific way different structural patterns shape motion see the analytical discussion below). On the one hand, we have the *fixed* musical parameters (mainly meter, durational patterns, melody, and harmony) that make up the compositional structure as it appears in the musical score, and on the other, the *variable* ones (tempo and dynamic fluctuation, and articulation), as shaped by the performer. In what follows, we will see in particular how important the variable musical factors (basically micro-dynamic and tempo fluctuation) are in shaping musical motion and subtle expressive effects.

Analysis of two measures from Chopin's Prelude op. 28 No. 17 (see Figure 3a) will apply the above theoretical framework and demonstrate the analytical process. The first step is to determine the contribution of the fixed musical parameters in the shaping of motion. As shown in Figure 3b, the main factors involved in measure 3 are the V7 harmony that increases MT as it approaches the tonic on the following downbeat accent, and the "anacrustic" or goal-directed durational pattern ("short-short-...long" from weak to strong beat) that increases RD. This motion pattern is reversed in measure 4, as suggested by the 9-8 suspension and the "metacrustic" or goal-dissipating rhythmic pattern (relatively long accented note followed by unaccented one) that ends the first melodic phrase. Notice how while the general motion process in these two measures is increase (++) and decrease (--) in both parameters, locally, as the accent is approached and left, these processes are shaped as -+|+- (the first sign in each pair always refers to MT and the second to RD). The increased acceleration right before the attack is necessary in order for the ball to bounce back up or for the musical accent to articulate the beginning of a new metrical group.

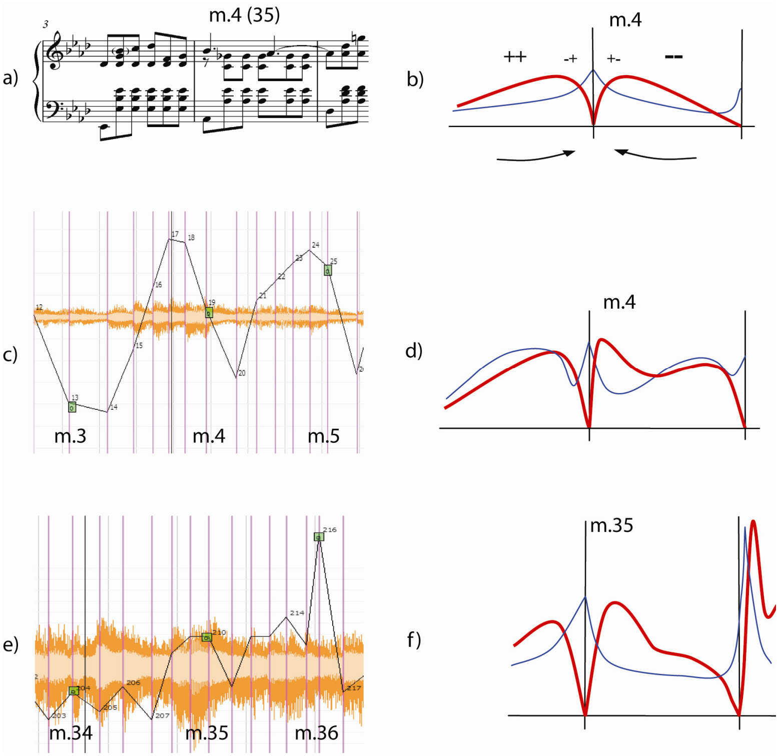

Figure 3. Chopin Prelude op. 28 No. 17, mm-3-4. (a) Musical score; (b) motion graph of fixed musical parameters; (c) tempo and dynamic fluctuation of Cyprien Katsaris's performance; (d) motion graph of Katsaris's performance; (e) tempo and dynamic fluctuation of Shura Cherkassky's performance; (f) motion graph of Cherkassky's performance. (See full color version at www.performancescience.org.)

The next step is to consider the variable or performance parameters (tempo and dynamic fluctuation). These have been extracted from the recordings of two performances of the excerpt using Sonic Visualiser, a newly developed program that allows one to listen, view, and analyze the contents of music audio files. (Intensity is indicated by the waveform and relative tempo values by the tempo graph: the green squares on the tempo graph indicate salient accents which in this case coincide with metrical downbeats.) Figure

3c shows tempo and dynamic fluctuation as shaped by Cyprien Katsaris, while Figure 3d shows how they modify the motion graph of the fixed musical parameters shown in Figure 3b, adding further expressive nuances.

The motions caused by the accelerando and crescendo in measure 3 are in phase with and thus further strengthen those of Figure 3b. While, however, the general motion process is ++, as the downbeat accent is approached, a local tempo decrease modifies RD as shown in Figure 3d, creating a "lower impact" accent. A similarly carefully-approached accent is also seen in the following measure. Compare this with the way Shura Cherkassky approaches the downbeat accents of the same passage from the recapitulation (mm.34-35). The first downbeat is approached with a crescendo and accelerando without any local tempo delay, giving a more forceful and edgy character to the accent. The second downbeat is approached even more forcefully, due to the surprisingly early entry of a dynamically stressed low D in the bass. Notice here how RD reaches its peak after the downbeat, as it is caused not by a gradual acceleration process in the previous measure but by the early entry of the bass note.

In order to appreciate the modelling described above, one has to listen to the musical examples while imagining or visualizing the corresponding bouncing ball motion. The program I envisage would allow one to do this, plus something even more important: the actual step-by-step *creation* of the animation. After inputting the sound file in the program and generating the tempo graph of the piece (as in Sonic Visualiser), the user would be guided to make a detailed structural analysis of the piece as explained above. In determining, however, the precise way musical structure shapes motion, a crucial final step will encourage one to "empathically" connect physical motion with musical motion (or experience) and structure. This is explained in Figure 4. After selecting the generic motion patterns from a list of pre-drawn shapes, on the basis of the structural analysis as shown in Figure 4a, the user will make the final adjustment of these patterns, to reflect details of expressive character, "by ear" or rather by "bodily sensation." This will entail a trial and error process where the user clicks, drags, and modifies the motion lines and then tests the animation in order to determine the exact amount of absolute value and degree of change of the two parameters of musical or ball motion. Such experiential mediation is essential to the pedagogical goal of the software, and distinguishes it from the fully quantified modelling that this theoretical framework might also enable.

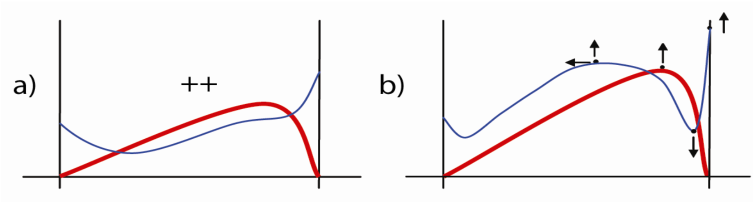

Figure 4. (a) Motion graph of the generic motion pattern of increase in both MT and RD; (b) modification of generic motion patterns. (See full color version at www.performancescience.org.)

IMPLICATIONS

What the analytical process proposed here hopes to achieve is integration between the mind and body in the understanding of music. By encouraging understanding of musical experience in both physical motion and abstract musical structure, it combines the objectives of both traditional college-level music theory and Eurhythmics, and promises to cultivate sensitivity to the rhythmic and expressive subtleties of music. Moreover, it makes possible the study of not only the compositional structure of music but also its performed structure, and provides a systematic way of describing musical expression. It can, therefore, be particularly useful for performance students and for listeners who are eager to understand better the expressive meaning of music.

Acknowledgments

Many thanks to Nicholas Cook and the research staff of the AHRC Research Centre for the History and Analysis of Recorded Music for their helpful feedback and to the creators of Sonic Visualiser (Centre for Digital Music, Queen Mary, University of London), which has made the study of performance interpretation much easier.

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Discography

Katsaris C. (1992) *Complete Preludes*. Sony SK 53355.

Cherkassky S.(1998). Chopin. In *Great Pianists of the Twentieth Century Series, Vol.17*. Philips 456 742-2.

International Symposium on Performance Science
ISBN 978-90-9022484-8

La cathédrale engloutie: Is musicology changing the way we perform?

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The recording of *La cathédrale engloutie* by Debussy himself revealed important differences between the score and the way he performed the music. This gave rise to a series of studies in musicology and to the posthumous correction of the score. The aim of the present work is to question the impact of musicological studies on performance practice. An overview of the most important documents concerning *La cathédrale engloutie* is presented, from the time when the work was published until the present. In addition to this, 38 recordings were examined to ascertain how performers played the work over this period. The results showed that Debussy's recording itself did not have a direct impact on the way performers play *La cathédrale engloutie* and that only after the score was rectified pianists gradually started changing the way they performed the work. The study confirmed the historical importance of Debussy's own recording, as well as the importance of the musicological studies for performance practice. However, the study also revealed that these findings take a long time to become known and accepted among professional pianists.

Keywords: Debussy; recordings; performance; interpretation; musicology

When Debussy wrote *La cathédrale engloutie* he omitted the changes of tempo (half-note=quarter-note) in two sections of the piece (bars 7-12 and 22-83). It is possible that he did not consider it necessary to give such indication, although this seems unlikely. He wrote a double indication of meter in the first bar, but this did not offer enough evidence for a performer to change tempo. The first edition of the first book of *Préludes* by Durand was published in 1911 with no indications as far as changes of tempo were concerned, and the mistake would lead several generations of pianists into a big problem of interpretation. If one starts the prelude at a slow tempo, "profondément calme" as is indicated in the score and does not change tempo for double speed in those two sections, one would turn the prelude into a funeral procession. On the other hand, to play the prelude with no changes of tempo one has to play it considerably faster, thus contradicting the composer's initial indication.

When Debussy recorded *La cathédrale engloutie* for Welte-Mignon in 1913, he played with the alterations of tempo that were absent in the score. However, this recording on a pianola was only accessible to very few listeners. Other pianists who recorded the work in the early days, such as Alfred Cortot (1931) or George Copeland (1933), also performed with the same tempo alterations, but their 78rpm recordings never raised controversy about this topic. Moreover, although there was an early orchestration of *La cathédrale engloutie* by Debussy's colleague Henry Busser (1917) that indicated the changes of tempo, it seems that Debussy's contemporaries who wrote about his music never mentioned the problem. One exception could appear to be in Schmitz's book about Debussy's piano works, where one can read: "all the voices must be closely integrated as to dynamics and timing" (Schmitz 1950). Nevertheless, as Cecilia Dunoyer describes, Schmitz was among those who "went to extraordinary pains to make the 6/4=3/2 work literally" (Dunoyer 1999). Only in 1962 was the recording by the composer himself made available in LP format. As a result, Charles Burkhart (1968) discussed these changes of tempo. The topic caused controversy but does not seem to have convinced musicians in general. In 1983, Roy Howat revealed mathematical evidence in favor of Debussy's recording. Howat compared a version of the original score with a version of the score according to Debussy's own recording, and he concluded that, if the piece was written as Debussy himself played it, it would be structured according to the mathematical proportion of the golden section. Due to these studies, the score was rectified by Durand in 1985.

MAIN CONTRIBUTION

This problem of tempo raises two interesting questions: (1) how was it possible to perform the work with such a big mistake in the score and (2) what were the consequences of these studies and of Debussy's recording for performance practice? An historical survey of the pianists who performed according to Debussy's intentions is useful to contextualize this question.

Table 1. List of recordings and correspondent versions: Debussy's recording or original score.

Year of recording	*Pianist*	*Changes of tempo according to:*
1913 (roll)	C. Debussy	Debussy
1925	M. Hess	Score
1931	A. Cortot	Debussy
1932	G. Copeland	Debussy
1953	R. Casadesus	Score
1953	W. Gieseking	Score
1954	M. Meyer	Score
1955	F. Gulda	Score
1961	S. Richter	Score
1970	D. Ciani	Score
1971	N. Lee	Score
1976	T. Paraskivesko	Debussy
1978	A. Michelangeli	Score
1979	C. Arrau	Score
1983	J. Rouvier	Score
1983	Y. Egorov	Score
1986	C. Ousset	Score
1990	J. B. Pommier	Debussy
1991	K. Zimerman	Score
1991	M. O'Rourke	Score
1992	P. Crossley	Debussy
1993	J. V. Immersel	Debussy
1994	J. Y. Thibaudet	Debussy (but at different places)
1995	M. Pletnev	Score
1996	P. Donohoe	Score
1996	F. J. Thiollier	Debussy
1996	Z. Kocsis	Debussy (but at different places)
1997	R. Howat	Debussy
1998	C. Yin	Score
1998	M. Pollini	Debussy
2002	N. Ogawa	Score (but differences in Section C)
2003	M. Tan	Score
2003	G. Pludermacher	Score
2003	R. Voltapek	Score
2004	E. Greenfield	Debussy

Table 1 (cont.)

Year of recording	*Pianist*	*Changes of tempo according to:*
2004	F. Braley	Score
2006	S. Osborne	Debussy
2007	J. Bavouzet	Debussy

Table 1 illustrates the pianists who follow the original score and those who play according to Debussy's own recording. Since the score was rectified in 1985 the number of recordings according to Debussy's version increased. Up to that point, besides the early examples of Copeland and Cortot, who knew the composer, only one pianist performed according to Debussy's intentions. Paraskivesko's recording was released in 1976, after the LP of Debussy (1962) and the paper of Burkhart (1968) were published. Indeed, because the recording of Paraskivesko was the first for many years to display the same choices of tempo as Debussy's recording, I have contacted him in order to ascertain the reason for his strategy. Paraskivesco stated that his decision was based purely on a question of musical logic and that he was not aware of either the studies by Burkhart or of Debussy's own recording. The double meter indication from the first bar of the Prelude led Paraskivesco to conclude that that was Debussy's intention.

The number of recordings between the publication of Howat's book and the new edition of the score (from 1983 to 1985) is not enough to conclude whether the book alone would have led to a change of attitude in performers, but it is unquestionable that after 1985, when Durand published Howat's edition, the number of performers who play according to Debussy's intentions increased. After 1985, this has been further discussed in a number of papers and book chapters (e.g. see Howat 1994, 1997; and Dunoyer 1999) and acknowledge in CD reviews by critics.

As far as the question of tempo is concerned, performers can be divided into three groups: (1) those who play like Debussy himself with the changes of tempo, (2) those who play in accordance with the original printed score, and (3) those who play with changes of tempo but not exactly in the places Debussy intended. Those pianists who play according to Debussy's recording respect the thematic correspondence among different sections within the work. Moreover, this is the only possible way of maintaining the same overall speed; starting at a slow tempo as indicated by the words "profondément calme." It seems that the particular case of tempo in Debussy's recording is one of the most significant cases of how a recording by a composer changed the way the score was interpreted. However, it is also surprising that after so many papers and books on the topic there are performers who still ignore this important data. This is probably a result of the tradition among many performers of not listening to recordings and ignoring the studies of musicology. They believe that they must find their own interpretations and that listening to recordings or reading others' ideas about the music might influence them and thus make their interpretations less personal. This may also reflect that the means of disseminating musicological studies in general and performance studies in particular may not be reaching their target audience with the desired impact.

IMPLICATIONS

This study reinforces the importance of Debussy's recordings and of literature on the topic. Moreover, it alerts performers to the contribution of musicology for performance practice and acknowledges a mistake that is being perpetuated in many recordings. This study offers implications in the way professional pianists and music students perform *La cathédrale engloutie*.

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References

Briscoe J. (1999). *Debussy in Performance*. London: Yale University Press.

Burkhart C. (1968). Debussy plays "La cathédrale engloutie" and solves metrical mystery. *Piano Quarterly*, *65*, pp. 14-16.

Debussy C. (1911). *Préludes: 1er Cahier*. Paris: Durand.

Debussy C. (1985). *Edition Critique des Oeuvres Complètes de Claude Debussy*, ed. Howat and Helffer. Paris: Durand-Costallat.

Dunoyer C. (1999). Debussy and early Debussystes at the piano. In J. Briscoe (ed.), *Debussy in Performance* (pp. 91-118). London: Yale University Press.

Howat R. (1983). *Debussy in Proportion: A Musical Analysis*. Cambridge: Cambridge University Press.

Howat R. (1994). Debussy and Welte. *Pianola Journal*, *7*, pp. 3-18.

Howat R. (1997). Debussy's piano music: Sources and performance. In R. Langham-Smith (ed.), *Debussy Studies* (pp. 78-107). Cambridge: Cambridge University Press.

Schmitz R. (1950). *The Piano Works of Claude Debussy*. New York: Dover.

Discography

Arrau C. (1979). Philips 420 393-2.
Bavouzet J. (2007). Chandos 10241.
Braley F. (2004). Naïve DR 2114 AV 103.
Casadesus R. (1953). Sony SM2K 60795.
Ciani D. (1970). Deutsche Grammophon 453 070-2.
Copeland G. (1932). Victor 7962.
Cortot A. (1931). Biddulph Recordings LWH 006.
Crossley P. (1992). Sony SK 52 583.
Debussy C. (1913). Pierian 0001 (also in: Bellaphon 690 07 0II).
Donohoe P. (1996). GMN C0106.
Egorov Y. (1983). EMI CDCFPSD 4805.
Gieseking W. (1953). EMI 5 65855-2.
Greenfield E. (2004). Centaur Records CRC2693.
Gulda F. (1955). Polygram PY 925 456 817-2.
Hess M. (1925). Nimbus NI 8807.
Howat R. (1987). Tall Poppies TP 164.
Immersel J. (1993). CCS 4892.
Kocsis Z. (1996). Philips 465 568-2.
Lee N. (1971). Audivis-Valois V 4440 AD 310.
Meyer M. (1954). EMI CZS7 67 405-2.
Michelangeli A. B. (1978). Deutsche Grammophon 449 438-2.
O'Rourke M. (1991). Chandos 9078.
Ogawa N. (2002). BIS CD-1205.
Osborne S. (2006). Hypérion CDA 67530.
Ousset C. (1986). EMI CDS7 47608 8.
Paraskivesko T. (1976). Caliope CAL 9831.
Pletnev M. (1995). H7372/3 (ref. National Sound Archive).
Pludermacher G. (2003). Transart Live TL 128.
Pollini M. (1998). Deutsche Grammophon 445 187-2.
Pommier J. B. (1990). Virgin Classics 61254 21.
Richter S. (1961). BBC L 4021-2.
Rouvier J. (1983). Denon COZ 17037-38.
Tan M. (2003). Divine Art 1092.
Thibaudet J. (1994). Decca 452 022-2.
Thiollier F. (1996). Naxos 8.553293.
Votapek R. (2003). Ivory Classics 73004.
Yin C. (1998). Marco Polo 8.225946.
Zimerman K. (1991). Deutsche Grammophon 435 773-2.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Motor control and learning: The basics of skilled instrumental performance

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This paper introduces some concepts from the field of motor learning and their possible applications to the doublebass. Basic issues of motor performance and perceptual-motor integration form a proposal to enhance skilled instrumental performance. Posture and motion are analyzed under principal guidelines of human ergonomics. Movements used in doublebass performance are abridged to the concept of the pendulum motion. Three topics form a concluding part and give suggestions to enhance skilled instrumental performance. While this investigation is focused on issues of doublebass performance, it might be also extended to other instruments, especially those which require bi-manual movement production and acquisition.

Keywords: doublebass; motor learning; sensory learning; perceptual-motor integration; pendulum motion

Over the past decade, researchers have taken various approaches to studying how musicians acquire and refine their skills as performers. Results from studies have even suggested that the music studio could be used as a fascinating laboratory for the study of teaching and learning in general.

Most doublebass students are still advised to study from method books published in the nineteenth century as a single source for preparing their professional career. Whereas violin, viola, and violoncello methods show a more or less unified approach on how to hold and perform the instrument (e.g. Galamian 1962), doublebass methods reveal a larger variety of techniques and postures (e.g. Simandl 1905, Streicher 1974, Wolf 1991). Based on these different factors, there is a great deal of disagreement and contradiction in the study literature concerning techniques and methods of playing the instrument. While investigating in this field, I discovered that findings from the field of human motor control and learning might well propose solutions to the many problems the doublebassist has to overcome in order to reach flawless performance, especially when performing as a soloist.

MAIN CONTRIBUTION

This article aims to open up a new comprehension of movement production for a more effective development of technical elements which are indispensable to produce skilled action on the doublebass.

Motor control and learning in instrumental performance

What exactly is the nature of motor control and how broadly should the term be applied when describing the movements of a performer? Simply and general stated, motor control is the study of posture and motion and the mechanisms that underlie them (Rose 1997). In the course of learning to play an instrument, a vast amount of coordinated movements has to be controlled and strengthened with practice, forming then a motor program which is conceived as a hierarchical structure and that translates information into action (Davidson 1991).

Proctor and Dutta (1995) believe that three plans organize selection, coordination, and hierarchy: the "degree of freedom problem," the "serial order problem," and the "perceptual-motor problem." First, the degree of freedom problem describes how a particular means for achieving a movement goal is selected from the numerous possible and alternative means. Second, the serial order problem deals with the sequences of movements in their hierarchy order and timing. Third, the perceptual-motor integration problem deals with the interrelations between perception and motor control.

When performing a simple action, like putting a key into a lock or placing the bow on the D-string of the doublebass, the limbs involved have the freedom to choose between a vast amount of movements the skeletal system has to offer. Sport science has long described posture and motion of the human body in three-dimensional axis (Ungerer 1977). By defining a similar concept for the doublebassist, the efficiency of movements, coordination, and an ergonomic posture can be easily related and efficiently improved. Figure 1 shows how a three dimensional working space might organize and put into relation movements of the left and right hand in doublebass performance.

The activity of the bow arm is defined by the setting of the four strings defining one dimension and the working space of all possible combinations (1a). The target of the left arm is defined by its fulcrum placed near the elbow. Incorporated in one pendulum movement are vibrato and shifting actions

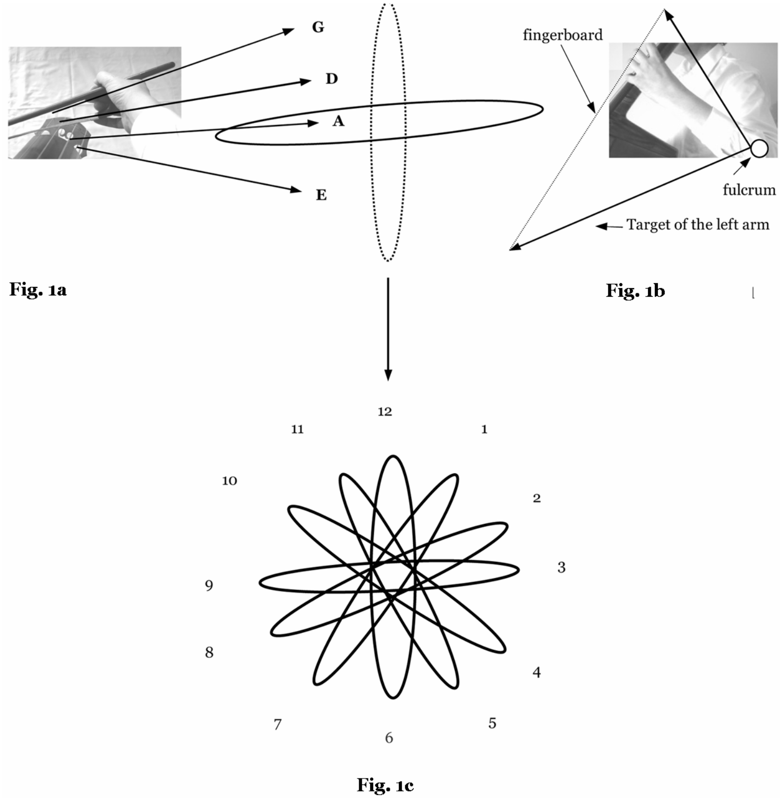

Figure 1. (a) Three dimensional space of the right arm. (b) Three dimensional space of the left arm. (c) A three dimensional working space for both hands.

with their underlying parameters (1b). In relating each movement to its possible "time zone" of an analogue watch placed in front of the hand like a mirror, it is possible to identify exactly the path of the arm and location (1c) (Wolf 1991). While the choice of movements might be applied to single motion, complexity arises when different kinds of movements have to be combined in hierarchical order. Lashley (1951) considers that movement sequences might involve sensory feedback in which one movement acts as the stimulus for the next in a series. Evidence suggestive of this hierarchical control has been obtained in studies using movement sequences that have some underlying structure. These underlying structures have been identified as important in building up hierarchical structures when forming motor

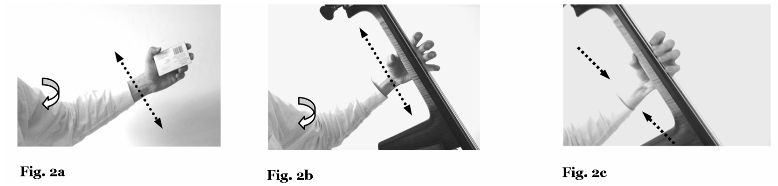

Figure 2. (a) Training the active and passive mode. (b) Exercise transferred to the instrument. Performance of the task.

programs in instrumental performance. When learning an instrument and then working on a specific piece of music, these programs will be built up. Wolf (1991) developed an analogical approach to sensory training to improve poorly established motor plans of doublebass students when learning, for example, vibrato, accurate finger-placing, shifting, or complex bow strokes. Wolf suggests that sensory training has to focus on the various types of simple and complex movements of the involved tasks in order to be effective. He also refers to the proprioceptive senses that are concerned with perceiving the body's own movement, its location, and the position of its limbs in space. A view that also has been highlighted in the design of sensory learning models in sports (Ungerer 1977) and ergonomics (Oborne 1987). Based on these concepts, the following exercise is suggested as a model to improve sensory ability when learning vibrato on the doublebass.

Shaking a matchbox (2a) in order to check the contents is a possible approach to experience the performance of active and passive mode. In this exercise, the hand that shakes the matchbox performs the active mode, whereas the rotational movement of the upper arm, as a result of the previous, is performed in a passive mode. The produced noise of the matches helps to orientate the motion in this stage. In a next step, the open hand will swing over the fingerboard, slowly closing it until the thumb and fingers slightly brush over the neck (2b). Now the size of the motion has to be gradually reduced to the size of the desired amplitude of motion. The movement adapts gradually to its working position (2c). When viewing the human body in action, it is evident that pendulum movements are predominant (Wolf 1991). A brief analysis of physical components provide some information about this system and in what type of activities might be used to enhance efficiency, coordination, and the economic use of muscular power (Pertzborn 2002).

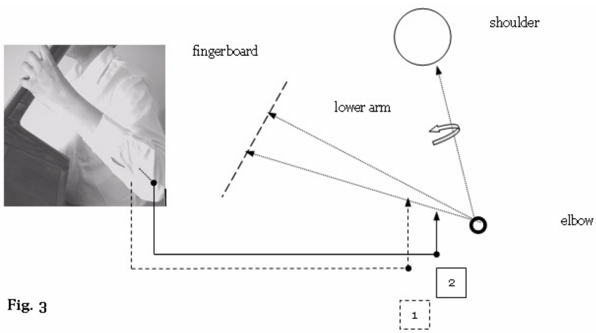

Fig. 3

Figure 3. The pendulum motion for the left hand.

One for all: The pendulum motion for doublebass technique

Pendulum motions are most efficiently used in continuous performance skills. Figure 3 shows the position of the left hand when performing a continuous skill like vibrato. The motion of the hand, upper arm, and lower arm is transferred into the diagram connected to the photo. The frequency of the vibrato might be reduced or augmented through the placement of the fulcrum (**o**): the movement becomes larger and thus faster when the fulcrum is moved towards the middle of the arm (1), decreases and slows down when moving towards the elbow (2). The pendulum motion, viewed in a three-dimensional context, might well be considered as a possible overall concept for the effective production of movements. Muscular tension and limited movement control frequently arise when this concept remains unconsidered.

IMPLICATIONS

With this paper, I have attempted to show that some concepts of motor control and learning might well form the basic guidelines to skilled performance:

1. The close relationship between posture and motion (Wolf 1991) can be confirmed as one of the essential elements of motor control.
2. Projecting the "degree of freedom" (Bernstein 1967) of movements to a three dimensional system is a viable way to define the location and spatial frame for both arms for the doublebass.
3. The pendulum-based movement is proposed as the integrative and most efficient movement to both posture and motion.

It is clear that investigation in this field is inherently complex and can only contribute to real life if training methods can be held simple and practical in order to meet musical goals. Further studies have to be undertaken in order to validate the present investigation. This could be done by observing the learning process of students and professionals. Movements could also be measured and related to the quality of their musical outcome.

Understanding and learning concepts from the area of human performance may help the learner to access unused potentials and surpass self imposed limits.

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References

Bernstein N. (1967). *The Coordination and Regulation of Movement*. London: Pergamon.

Davidson J. (1991). *Expressive Body Movements in Piano Performance*. Unpublished doctoral thesis, City University London.

Lashley K. S. (1951). The problem of serial order in behavior. In L. A. Jeffress (ed.), *Cerebral Mechanisms in Behavior* (pp. 112-136). New York: Wiley.

Oborne D. J. (1987). *Ergonomics at Work* (2nd ed.). Chichester: Wiley.

Pertzborn F. (2002). Learning the doublebass: A multilevel approach to the acquisition of motor performance skill. *Per Musi: Revista de Performance Musical*, *5-6*, pp. 120-130.

Proctor R. W. and Dutta A. (1995). *Skill Acquisition and Human Performance*. Thousand Oaks, California, USA: Sage.

Rose D. J. (1997). *A Multi-level Approach to the Study of Motor Control and Learning*. Boston: Allyn and Bacon.

Ungerer D. (1977). *Zur Theorie des Sensomotorischen Lernens*. *Beiträge zur Lehre und Forschung im Sport* (vol. 36). Schorndorf, Germany: K. Hoffmann.

Wolf M. (1991). *Principles of Doublebass Technique* (vol. 1). Essen, Germany: Die blaue Eule.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Schubert's lament: Original reading

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The *topos* of lament is expressed upon the idiosyncratic leading-tone polarity of the minor mode (scale degrees 5-*b*6-5). I have traced both its evolving manifestations and critical significance in tonal music, syntactic as well as systemic, from Monteverdi's *Lamento d'Arianna* to Mahler's *Kindertotenlieder*. A new cognitive model was put forth therein, that is based on the paradigm of harmonic modulation as an essentially plastic process. Following Beethoven's lead, Schubert developed a consistent chromatic approach to the mixture of modes (major-minor parallel keys). In his lieder, particularly, he was to cast and coin the old lament-motive tradition in the context of the early-Romantic aesthetics, while further extending the critical role of the flat-submediant region and the attendant major-third relationship (I/I-*b*VI). The present study attempts to explain how Schubert's musical interpretations (or readings) of Rückert's "Du bist die Ruh'" and "Lachen und weinen" aptly represent, and actually enhance, the core meaning of the poems. Of course, the paradigm of harmonic modulation will be applied thereto. The qualifier "original" in the title has a twofold meaning: it denotes a novel analytical approach to the composer's settings; these, in turn, were the source of (or role model for) subsequent developments.

Keywords: analysis; flat-submediant region; harmonic modulation; lament-motive; lied

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International Symposium on Performance Science
ISBN 978-90-9022484-8

Integration of improvisation in violin lessons: Why and how to build an accessible and efficient didactic tool

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Integrating into teaching pedagogical activities that encourage young violin players' decisional latitude, such as improvisation, appears to be a relevant way to lessen the constraints inherent to their psychosocial learning context. However, improvisation is almost absent from Western classical instrumental teaching and particularly from violin teaching. Moreover, pedagogical or didactical materials that offer a progressive approach to the teaching of improvisation in the context of Western classical music are rare and unsuited to the context of individual violin teaching. Our research aims at filling this gap by designing a didactical tool to help teachers integrate improvisation into their individual classes in the first three years of learning. This article describes the methodological approach we used to design a didactical tool that would meet the needs of both teachers and researchers.

Keywords: improvisation; violin; teaching-learning context; didactic tool; decisional latitude

The teaching of Western classical violin offered in individual classes is often done in a highly constraining psychosocial learning context (Persson 1995). The teaching strategies that are utilized leave very little decisional latitude to the student (Persson 1995). According to a model by Karasek and Theorell (1990), a work environment demanding great psychological involvement and leaving little decisional latitude is likely to result in physical and psychological tensions. These problems plague a vast majority of musicians (Berque and Gray 2003, Fjellman-Wiklund *et al.* 2003) and may originate in their early learning years (Burkholder and Brandfonbrener 2004). Although the causes of the beginning and of the continuation of these tension problems may be associated to various factors, they often take root in the psychosocial constraints related to the work or learning environment (Flor *et al.* 1985; quoted by Berque and Gray 2003).

In addition, a work environment that is psychologically demanding and allows great decisional latitude promotes motivation and learning (Karasek and Theorell 1990). Consequently, integrating creative pedagogical activities that encourage young violin players' decisional latitude appears to be a pertinent alternative. Improvisation catches our attention because it naturally solicits the student's decision at every moment (Azzara 2002). Moreover, integrating improvisation in musical and instrumental training promotes the comprehension and the acquisition of musical concepts and structures (Azzara 1992, McPherson 1993, Montano 1983, Wilson 1971; all cited by Azzara, 2002).

However, improvisation is almost absent from Western classical instrumental teaching (Azzara 2002, Bitz 1998, Burrows 2004) and particularly from violin teaching (Biesenbender 2001, Riveire 1997). Several researchers stress the necessity of informing teaching musicians of the benefits of improvisation in their teaching and of providing them with adequate improvisation materials (Azzara 1999, Bitz 1999, Della Pietra and Campbell 1995, Jørgensen 1998, Riveire 1998). Unfortunately, pedagogical or didactical materials that offer a progressive approach to the teaching of improvisation in the context of Western classical music are rare and unsuited to the context of individual violin teaching. Our research aims to fill this gap by designing a didactical tool to help teachers integrate improvisation into their individual classes in the first three years of learning.

MAIN CONTRIBUTION

The goal of this study is to elaborate a didactic tool that facilitates the integration of improvisation into violin teaching. This tool will allow teachers to familiarize themselves with improvisation and use it as a relevant teaching strategy.

Elaboration of a didactical tool: Methodology

Designing a didactical tool requires a specific methodology called "development research." Van Der Maren (2003) breaks it down into four stages: (1) market analysis, (2) object analysis, (3) preparation, and (4) development. This is the methodological model followed in our present research project.

Market analysis

Market analysis corresponds to the analysis of the needs related to a problematic situation: a gap is observed and can be filled by developing a tool. So as to ensure the relevance and efficacy of this tool, we must ask ourselves: who is it for? What objective does it serve? In what context will it be used? This stage allows one to identify the specifications that determine the functions of the materials being designed.

The tool we are developing aims to help violin teachers integrate notions of improvisation into their individual lessons. The teachers will be able to consult it to acquire the basic theory of improvisation, to think up strategies to integrate improvisation into their lessons, to progressively build up their students' improvisation skills, and to acquire strategies to guide the students' learning. Some constraints must be taken into consideration during the elaboration of this tool, such as the teachers' lack of experience with improvisation, the lack of time available during lessons, and teaching habits that ought to be respected.

Object analysis

Object analysis constitutes the theoretical part of development research. First, the contents, structure, and presentation of the database used to design the materials have to be completed. The conceptualization of the tool in order to elaborate a model then follows. The database used as a theoretical framework to design this tool is composed of the following elements: (1) the principles related to the creative musical thought process from Webster's model (1990, 2002); (2) certain improvisation teaching principles and strategies by Azzara and Grunow (2006) and Kratus (1991); (3) the technical objectives of three violin programs from schools recognized by the *Ministère de l'Éducation du Québec* (Canada); and (4) the principles of Rolland's (1959) and Szilvay's (1977) pedagogical approach of violin.

Preparation

Once the tool has been modeled, the third phase is the construction of the prototype. According to Van der Maren (1995), it is important to elaborate several different versions of the tool. The most appropriate version is determined according to its optimal satisfaction of the specifications, its feasibility, and the use of it made by its potential users. It is then important to investigate how feasible the proposed tasks are, and whether we should add information or modify the material or educational environment in order for the tool to be used. The chosen version will then serve to build the prototype that will be tested on a target population sample.

Development

The last tool development stage begins with the testing of the prototype. So as to avoid overexploiting resources (time, money, students, or teachers), Van Der Maren suggests to start with an evaluative chain of clinical tests. The prototype is subjected to a series of "adaptive-interactive" tests based on Stolovitch's *Learner Verification and Revision* (1982; quoted by Van Der Maren 1995), first applied to one subject, then, after other tests and modifications, to the other subjects. When the control chain collects little or no suggestions for improvement, the testing prototype becomes the final prototype.

Our approach corresponds to a type of development research called "collaborative". We will undertake demand analysis and preparation in collaboration with three teachers to ensure that the research object reflects the music teachers' concerns, constraints, and priorities. The prototype will then be validated in a teaching context with a selection of their 7 to 11 year-old students.

IMPLICATIONS

The methodology summarized here will allow us to develop a solidly designed didactical tool. This tool will permit the integration of improvisation into individual violin teaching, thus contributing to leaving more decisional latitude to the student in his or her instrumental learning. Besides, this "collaborative" development research approach promotes the confrontations of ideas drawn from theory and practice and contributes to the building of bridges between the communities of researchers and teachers.

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References

Azzara C. (2002). Improvisation. In R. Colwell and C. Richardson (eds.), *The New Handbook of Research on Music Teaching and Learning* (pp. 171-183). Oxford: Oxford University Press.

Azzara C. (1992). *The Effect of Audiation-based Improvisation Techniques on the Music Achievement of Elementary Instrumental Music Students*. Unpublished doctoral thesis, Eastman School of Music, University of Rochester.

Azzara C. D. and Grunow R. F. (2006). *Developing Musicianship through Improvisation*. Chicago: GIA Publications Inc.

Berque P. and Gray H. (2003). Influence de la douleur cou-épaule sur l'activité du muscle trapèze supérieur chez des violonistes et altistes professionnels. *Médecine des Arts, 43*, pp. 8-15.

Biesenbender V. (2001). *Plaidoyer pour L'improvisation dans L'apprentissage Instrumental* (C. Barret, trad.). Paris: Van de Velde. (Original work published in 1992.)

Bitz M. E. (1998). *A Description and Investigation of Strategies for Teaching Classroom Music Improvisation*. Unpublished doctoral thesis, Dissertation Abstract International, A 59 (10), p. 3767. (UMI No. 9909407).

Burkholder K. R. and Brandfonbrener A.G. (2004). Performance-related injuries among student musicians at a specialty clinic. *Medical Problems of Performing Artists, 18*, pp. 116-122.

Burrows J. (2004). *Resonances: Exploring Improvisation and its Implications for Music Education*. Unpublished doctoral thesis, Simon Fraser University.

Della Pietra C. J. (1997). *The Effects of a Three-phase Constructivist Instructional Model for Improvisation on High-school Students' Perception and Reproduction of Musical Rhythm*. Unpublished doctoral thesis. University of Washington.

Fjellman-Wiklund A. B., Brulin C., and Sundelin G. (2003). Physical and psychosocial work-related risk factors associated with neck-shoulder discomfort in male and female music teachers. *Medical Problems of Performing Artists, 18*, pp. 33-41.

Karasek R. and Theorell T. (1990). *Healthy Work Stress, Productivity and the Reconstruction of Working Life*. New York: Basic Books.

Kratus J. (1996). A developmental approach to teaching music improvisation. *International Journal of Music Education*, 26, pp. 27-38.

Persson R. S. (1995). Psychosocial stressors among student musicians: A naturalistic study of the teacher-student relationship. *International Journal of Art Medicine, 4*, pp. 7-13.

Riveire J. H. (1997). *California String Teachers' Curricular Content and Attitudes Regarding Improvisation and the National Standards*. Unpublished doctoral thesis, University of Southern California. Dissertation Abstract International, A 59/05, p. 1504. (UMI No. 9835075).

Rolland P. (1991). *L'enseignement du Mouvement dans le Jeu des Cordes* (C. Masson-Bourque, trad.). Quebec City, Québec, Canada: Les presses de l'Université Laval.

Szilvay G. (1977). *Violin ABC* (vol. 1 and 2). Sudbury: Colourstrings International.

Van der Maren J. M. (2003). *La Recherche Appliquée en Pédagogie : Des Modèles pour L'enseignement* (2nd ed.). Brussels: De Boeck Université.

Van der Maren J. M. (1995). *Méthodes de recherche pour l'éducation*. Brussels: De Boeck Université.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Epidemiology of musician's dystonia: Experience from the London clinic, 2002-07

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Musician's dystonia is a movement disorder presenting as incoordination, involving single or several fingers. The symptoms are either highly task-specific and occur only during playing, or involve other fine motor tasks, such as writing. It is unclear whether there are epidemiological differences between highly task-specific and the non task-specific form of musician's dystonia, which may indicate a different pathophysiology. We review epidemiological data of 124 musician's dystonia patients (86 male/38 female) seen in London during 2002-07. We compare the variables gender, age at symptom onset, professional position, instrument, and music style in highly task-specific (n=83) and non task-specific cases (n=41). The results strongly suggest a difference in the epidemiology. The *task-specific* form shows distinctive features, such as a significantly earlier onset, relative specificity for practice-intensive instruments (keyboard, plucked string) and predominance for classical musicians. The *non-task-specific* cases appear to be more similar to other forms of focal hand dystonia, such as writer's cramp. We suggest that the amount and intensity of musical training may be a crucial pathophysiological factor in the task-specific form of musician's dystonia but is less important in the non task-specific form.

Keywords: musician's dystonia; epidemiology; pathophysiology

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International Symposium on Performance Science
ISBN 978-90-9022484-8

The tuned brain: Enhanced brain plasticity in musicians

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Playing a musical instrument at a professional level is one of the most complex skills a human can achieve and is the result of intense practice started at an early age. It has been shown previously that the musician's brain adapts to this demand by changing its structure in brain areas involved in musical practice, such as the motor cortex. In the present study, we show that long-term musical training also influences the way in which the motor part of the brain regulates its own excitability and changes the strength of synaptic connections. These findings suggest that activity in the motor part of the brain is more precisely "tuned" in professional musicians than in non-musicians, which most likely supports their excellent motor skills.

Keywords: motor cortex; excitability; plasticity; transcranial magnetic stimulation; motor training

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International Symposium on Performance Science
ISBN 978-90-9022484-8

Sensory immersion training for concert artists

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This advanced training program aims to train stage artists to identify and reverse the narrowing sensory reactions typical of fear. The resultant sensory re-conditioning tends to increase stage wellbeing and enhance the communicative and creative qualities of musical performance. I have generated early drafts of appropriate teaching materials. This essentially practical method for combining focal and peripheral sensory attention suggests a clarification and redefinition of the general concept of concentration. The resulting sensory immersion appears not only to reduce fear, but also to form an essential foundation for the full personal engagement characteristic of high level musical performance. Following on from a 2-year research project at the Guildhall School of Music and Drama (GSMD), 2005-07, I am currently launching a 1-year collaborative experimental venture between GSMD and Goldsmith's College to investigate scientifically the hypothesis that spreading visual and/or auditory spatial attention tends to deactivate the fear responses; it is jointly funded by GSMD and the London Centre for Arts and Cultural Enterprise (LCACE).

Keywords: fear; attention; music; performance; creativity

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International Symposium on Performance Science
ISBN 978-90-9022484-8

The learning of music as a means to improve mathematical skills

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Music improves the development of our brains and helps to improve our abilities in other subjects such as reading and mathematics. From simple sums to complex functions, mathematical concepts form part of the world of music. Because of this connection, it is possible to establish a positive correlation between participation/performance in music and cognitive development in mathematics. Gardner's theory of multiple intelligences incited several researchers to re-examine the relationships between musical experiences, music learning, and academic achievement. The majority of studies have found that the most significant relationships are between music and mathematics, or to be more specific, between music and spatial-temporal reasoning (important in mathematical concepts), and music and performance in reading. With regard to the former relationship, the assumption is based on a group of studies which explore the effects of learning to play the keyboard on spatial-temporal reasoning, suggesting that mastering a musical instrument helps one to develop an understanding of mathematics. Furthermore, neuroscientific research has been carried out which associates certain types of musical practice to the cognitive development of humans.

Keywords: music; mathematics; spatial-temporal reasoning; brain; mathematical achievement

The present work aims to contribute to a better understanding of the connection between music and mathematics. More specifically, it intends to examine whether musical experiences and learning may enhance mathematical performance. In order to achieve that purpose a revision of related literature was carried out, which was divided into three themes: music and mathematics; music, spatial-temporal reasoning, and mathematical achievement; and music and the brain.

MAIN CONTRIBUTION

Music and mathematics

The present work refers to the way in which the basic elements of music are related to mathematics. Firstly, notes, intervals, scales, harmony (consonance and dissonance), tuning, and temperaments are related to proportions and numerical relations, integers, and logarithms (Beer 1998). Secondly, mathematical concepts are present in melody and rhythm; musical notation includes concepts of time (length of notes, bar lines, and time signatures), rhythm (beat and the grouping of notes in tempos), pitch (clefs, staff, and frequency of the sound), and dynamics (signs of graduation of intensity), all in the circle of musical space (geometry of music). These elements are related to certain arithmetical operations (division, multiplication, addition, and logarithmic function), trigonometry, and geometry (Beer 1998, Fauvel *et al.* 2006). Third, mathematical patterns, "friezes", and motifs (types of symmetries) have been employed in musical compositions by a number of composers within geometrical ideas. Some examples are the motet *Non vos relinquam orphanos* by Byrd, fugues by J. S. Bach, and *Le courlis cendré* from the *Catalogue d'oiseaux* by Messiaen, among many others (Fauvel *et al.* 2006). Lastly, the mathematical concepts of the "Fibonacci sequence" and the "Golden Section" theory may be found in musical compositions, such as piano sonatas by Mozart (Garland and Kahn 1995, May 1996). We may thus conclude that music is connected to several different areas of mathematics: arithmetic, geometry, and trigonometry.

Music, spatial-temporal reasoning, and mathematical achievement

Gardner (1993) suggests that each individual possesses a portfolio of distinct forms of intelligence. In this context, the musical ability is seen as its own discreet domain of intelligence. Gardner (1997, p. 9) states that "music may be a privileged organizer of cognitive processes, especially among young people." There appear to be connections between musical capabilities and certain spatial capabilities. In addition to encompassing the concept of autonomous forms of intelligence, these interpretations allow for the possibility of an experience in a given area having an influence on performance in another area (Rauscher and Zupan 2000). Some of the effects measured in musical research have strong links with the capability of spatial reasoning, notably mathematics and reading. Musical experiences or musical learning are particularly related with music audition (Rauscher *et al.* 1995, Hetland 2000) and instrumental and/or vocal learning (Rauscher *et al.* 1997, Costa-Giomi 1999, Graziano *et al.* 1999, Rauscher and Zupan 2000, Martinez *et al.* 2005). Moreover, regarding the relationship between music and spatial intelligence, it should be mentioned that "playing a melody involves reconstructing a spatial-temporal pattern in which the elements are not puzzle pieces but notes of high and low pitches of long and short duration" (Rauscher 1997, p. 31). An analysis of these studies enables us to say that music facilitates cognitive learning, particularly in the field of logical reasoning, spatial reasoning, and abstract reasoning. It is thus possible to affirm that musical teaching improves proportional reasoning related to certain mathematical concepts, such as the understanding of fractions and ratios (Rauscher and Zupan 2000), and confirms the role of spatial-temporal reasoning in a number of mathematical operations. These inferences are important because the understanding of proportional mathematics and fractions is a pre-requisite for the grasping of mathematics at higher levels (Vaughn 2000). Along different lines of research, there are a number of studies which explore the positive effects of musical learning on academic performance, notably in terms of mathematical achievement (Graziano *et al.* 1999, Vaughn 2000, Gouzouasis *et al.* 2007). Considering the literature referred to here, we may say that the effects of music on academic performance stand at a medium level. However, it is possible to conclude that certain musical experiences have a positive impact on academic achievement under given circumstances (Hodges and O'Connell 2005).

Music and the brain

What has been said so far suggests the existence of an interaction between music and the brain, and demonstrates that music and the teaching of music to children and youths results in an optimization of their spatial-temporal and mathematical performances. The structured neuronal model of the cerebral cortex developed by Leng and Shaw (1991), named the "trion model," provides the neuroscientific context for the relationship between music and spatial cognition. Behavioral studies motivated by this model have found a causal relationship between music and spatial-temporal reasoning (Rauscher *et al.* 1995). The tasks of reading music and instrumental performance involve a variety of capabilities, and that provides plausible explanations for the teaching of music leading to transfer effects in other areas, such as the fact of musical practice having the capacity to improve spatial reasoning, as notation in music is itself spatial. On the other hand, mathematical capabilities may also be improved by musical learning (Schlaug *et al.* 2005). Stewart (2005) suggests that, as a result of learning how to read and play keyboard music, pianists acquire vertical/horizontal visual-motor mapping which becomes generalized beyond the musical context. The neural correlatives of the link previously assumed between the formal teaching of music and mathematical achievement were researched by Schmithorst and Holland (2004) through the use of fMRI. Musical practice has been associated with enhanced activation in the left fusiform gyrus and prefrontal cortex and decreased activation in visual association areas and the left inferior parietal lobule during mathematical tasks. Schmithorst and Holland (2004) believe that the correlation between musical teaching and mathematical achievement may be associated with the improved performance of short-term memory and an increase in the abstract representation of numerical quantities. Experimental projects show that formal musical training and informal experience in diverse environmental situations lead to measurable changes in the neurochemistry and even in the neuroanatomy of the brain (Black and Greenough 1998). Certain parts of the brains of adult musicians which are related to musical tasks and musical processing are larger (Schlaug *et al.* 1995, Hutchinson *et al.* 2003) and more energetically activated (Schmithorst and Holland 2004, Koelsch *et al.* 2005, Schlaug *et al.* 2005).

IMPLICATIONS

What has been said demonstrates the existence of a correlation between musical experiences and learning with cognitive performance, notably in mathematics. This fact has important educational implications, especially in regards to the inclusion or maintenance of the teaching of music in the national school curriculum of both children and adolescents.

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References

Beer M. (1998). *How do Mathematics and Music Relate to Each Other?* Brisbane, Queensland, Australia: East Coast College of English.

Black J. E. and Greenough W. T. (1998). Developmental approaches to the memory process. In J. Martinez and R. Kesner (eds.), *Neurobiology of Learning and Memory* (pp. 55-88). San Diego, California, USA: Academic Press.

Costa-Giomi E. (1999). The effects of three years of piano instruction on children's cognitive development. *Journal of Research in Music Education*, *47*, pp. 198-212.

Fauvel J., Flood R., and Wilson R. (2006). *Music and Mathematics: From Pythagoras to Fractals*. Oxford: Oxford University Press.

Gardner H. (1993). *The Theory of Multiple Intelligences*. New York: Basic Books.

Gardner H. (1997). Is musical intelligence special? In V. Brummett (ed.), *Ithaca Conference '96 Music as Intelligence: A Sourcebook* (pp. 1-12). Ithaca, New York, USA: Ithaca College Press.

Garland T. H. and Kahn C. V. (1995). *Math and Music: Harmonious Connections*. Palo Alto, California, USA: Dale Seymour Publications.

Gouzouasis P., Guhn M., and Kishor N. (2007). The predictive relationship between achievement and participation in music and achievement in core Grade 12 academic subjects. *Music Education Research*, *9*, pp. 81-92.

Graziano A. B., Peterson M., and Shaw G. L. (1999). Enhanced learning of proportional math through music training and spatial-temporal training. *Neurological Research*, *21*, pp. 139-152.

Hetland L. (2000). Listening to music enhances spatial-temporal reasoning: Evidence for the "Mozart effect." *Journal of Aesthetic Education*, *34*, pp. 105-148.

Hodges D. A. and O'Connell D. S. (2005). The impact of music education on academic achievement. *Sounds of Learning: The Impact of Music Education*, available at http://www.uncg.edu/mus/soundsoflearning.html.

Hutchinson S. *et al.* (2003). Cerebellar volume of musicians. *Cerebral Cortex*, *13*, pp. 943-949.

Koelsch S., Fritz T., Schulze K. *et al.* (2005). Adults and children processing music: An fMRI study. *Neuroimage*, *25*, pp. 1068-1076.

Leng X. and Shaw G. L. (1991). Toward a neural theory of higher brain function using music as a window. *Concepts in Neuroscience*, *2*, pp. 229-258.

Martinez M. E. *et al.* (2005). Music training and mathematics achievement: A multi-year, iterative project designed to enhance student learning. Paper presented at *The Annual Conference of the American Psychological Association*, Washington, DC.

May M. (1996). Did Mozart use the golden section? *American Scientist*, *84*, pp. 118-119.

Rauscher F. H. (1997). A cognitive basis for the facilitation of spatial-temporal cognition through music instruction. In V. Brummett (ed.), *Ithaca Conference '96 Music as Intelligence: A Sourcebook* (pp. 31-44). Ithaca, New York, USA: Ithaca College Press.

Rauscher F. H., Shaw G. L., and Ky K. N. (1995). Listening to Mozart enhances spatial-temporal reasoning: Towards a neurophysiological basis. *Neuroscience Letters*, *185*, pp. 44-47.

Rauscher F. H., Shaw G.L., Levine L.J., *et al.* (1997). Music training causes long-term enhancement of preschool children's spatial-temporal reasoning abilities. *Neurological Research. 19*, pp. 2-8.

Rauscher F. H. and Zupan M. (2000). Classroom keyboard instruction improves kindergarten children's spatial-temporal performance: A field experiment. *Early Childhood Research Quarterly*, *15*, pp. 215-228.

Schlaug G., Jäncke L., Huang Y., *et al.* (1995). Increased corpus callosum size in musicians, *Neuropsychologia, 33*, pp. 1047-1055.

Schlaug G., Norton A., Overy K., Winner E., *et al.* (2005). Effects of music training on the child's brain and cognitive development. *Annals of the New York Academy of Sciences*, *1060*, pp. 219-230.

Schmithorst V. J. and Holland S. K. (2004). The effect of musical training on the neural correlates of math processing: A functional magnetic resonance imaging study in humans. *Neuroscience Letters*, *354*, pp. 193-196.

Stewart L. (2005). A neurocognitive approach to music reading. *Annals of the New York Academy of Sciences*, *1060*, pp. 377-386.

Vaughn K. (2000). Music and mathematics: Modest support for the oft-claimed relationship. *Journal of Aesthetic Education*, *34*, pp. 149-166.

International Symposium on Performance Science
ISBN 978-90-9022484-8

From quantitative empirï to musical performology: Experience in performance measurements and analyses

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The term performology is introduced to describe the performer's "attempted control" of an acoustical instrument or a sound device. Four examples of performance analyses are discussed, three based on repeated MIDI recordings (Yamaha Disklavier grand and upright) and the last one based on repeated anechoic flute recordings.

Keywords: performance studies; music technology; methodology; acoustical measurements

The development of procedures and methodology for studying music performances has been heavily influenced by existing technology. Ortman (1929) made a lot of observations by visual inspection of piano players and developed a measuring device based on a mechanical pantograph.

New digital data technology including the MIDI data protocol has increased the possibilities to get reliable performance data in an easy way, far away from the qualitative opto-mechanical studies by Ortman. However, it is still a challenge to establish reliable data acquisition systems and procedures, define system precisions, and evaluate data reliability.

Repp (1999) has combined old and new techniques for the procedure of subjective evaluation and synthesizer simulations in the comparison of more than 100 recorded performances of the opening of Chopin's *Etude in E major* in an attempt to judge performance quality. One conclusion is "that very different patterns of timing and dynamics are aesthetically acceptable for the same music," which is in agreement with the statement in Tro (1998): "we may even have to accept a number of equally ranked families of phrasing patterns, or velocity contours, in the evaluation of performance quality."

The word "performology" has more or less become a standard term for the knowledge about—and the description of—the performer's activity during a performance. It may be preferable to limit the term to describe the "attempted control" of the instrument. This includes the overall or macro type of movement and behavior and at the same time all the micro type of muscle control and detailed fingering, intended or not.

In this sense, performology is for the musician what human computer interaction (HCI) is in the computer science world. We can call this field of research "musician instrument interaction" (MII) when we talk about standard acoustical instruments or "musician controller interaction" (MCI) when we consider general sound control devices.

Here, performology has so far been linked to a solo performance situation, i.e. one performer controlling one instrument. An intriguing broadening of the term could be the study of ensemble performances with several different instruments (symphony orchestra, big bands) or groups with several similar instruments (strings, brass, voices). Examples of performology research with solo piano and flute performances are shown below.

METHOD

Reported experiments are based on laboratory data from MIDI recordings and acoustical recordings with professional and semi-professional performers.

Procedure

All the presented piano analyses are based on MIDI recordings with calibrated equipments (Yamaha Disklavier Grand, CME/CRCA, San Diego, and Yamaha Disklavier Upright, model MX-100B, NTNU, Trondheim).

The first example is a simple dynamical control test. The ability to perform a slowly increasing crescendo by tapping one key repeatedly on the grand piano keyboard gives us an indication of the highest possible dynamical precision and sound level resolution in a piano performance as reported in Tro (2000). The performer was asked to play one crescendo from very soft to very loud by tapping the middle C on the keyboard repeatedly as many times as necessary. Then the performer was immediately asked to do one more performance. A third attempt was recorded too.

The second example is analyses of the dynamical contour of the eight starting tones of the Rondo movement from the *Sonata Pathetique* of Beethoven. The average dynamical contour of 20 recordings of one Norweg-

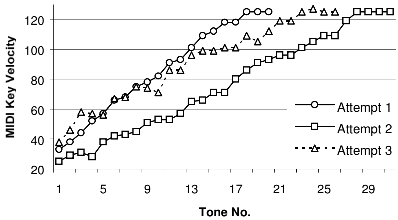

Figure 1. Crescendo performance with one key from three consecutive recordings.

ian semi-professional pianist is compared to the contour performed by Gerhard Oppitz in a professional Yamaha recording session 1988.

The third example concerns key attack precision in two consecutive chords (measures 16 and 17) in the previously mentioned Beethoven sonata. These two five-tone chords have been extracted from seven performances (one professional pianist) of the complete Rondo movement and analyzed.

The fourth example concerns key and blowing control in flute playing. Five versions of a flute concerto have been recorded as reported in Tro *et al.* (2003). One main question discussed is the actual precision for single tone onsets in staccato phrases, based on the fact that you have to control the key actions before the blowing tone transient starts in order to obtain the expected pitch.

RESULTS

Figure 1 shows single key crescendos. The dynamic steps vary from 1 to 10, measured in MIDI Key Velocity steps. The average step size was close to 3.

The different results of the three consecutive attempts may be explained by one psychological and physiological rehearsal-motivated effect (from attempt 1 to a better result in attempt 2), and one fatigue effect (from a superb performance in attempt 2 to a poorer controlled performance in attempt 3).

A second professional piano performer obtained a similar effect. Figure 2 shows the dynamical contour of the eight starting tones in the previous mentioned Beethoven composition. The upper curve is an average of 20 recordings of one Norwegian semi-professional performer. The lower curve shows the similar data for one professional Yamaha recording by Gerhard Oppitz, 1988. (The difference in absolute values is probably due to different mechanical adjustments of the two Disklavier used). Both contours in Figure

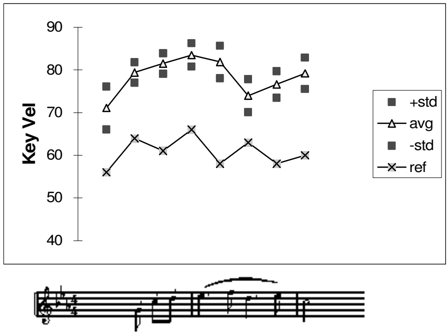

Figure 2. Comparison of performed dynamical contours.

2 sound musically acceptable and may be ranked equally in an aesthetical evaluation despite clearly significant differences.

Performance precision in piano chords is shown in Figure 3 (from Tro 1999). Two semi-ending five-tone chords (G major and C minor, measures 16 and 17, Beethoven sonata) have been extracted from seven recordings by one performer. We could expect all five tones to appear simultaneously for both chords. However, the analyses indicated that the two chords were performed with a significant different precision. The precision of the first chord did vary with no clear trend from take to take.

Figure 3 shows the key order of performer A's second chord. The MIDI Key numbers 36, 48, 72, 75, and 84 form a C minor chord. Here the order of keys, i.e. the order of performed tones, is remarkably constant with always the right hand "melodic" fifth finger (key 84) coming first and the left hand fifth finger's bass tone (key 36) always coming last. This may be explained as a fully controlled rapid arpeggio from high to low pitch in order to control the instrumental timbre.

Five versions of a flute concerto have been digitally recorded in an anechoic chamber (Tro, Bjerkvik, and Kristiansen 2003). One main question discussed is the actual precision and timing for single tone onsets in staccato phrases, based on the fact that you have to control the key actions before you start the blowing tone transient.

The repeatability in frequency was remarkable. Through ten identical phrases the single tone frequency was on average 740.2 Hz (SD 1.8 Hz). ISO pitch standard expects 740.0 Hz. A defined time delay τ_i (time distance from the start of the key action sound to the maximum amplitude of the following

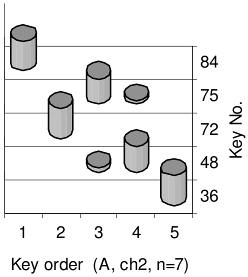

Figure 3. Key order of ending c minor chord.

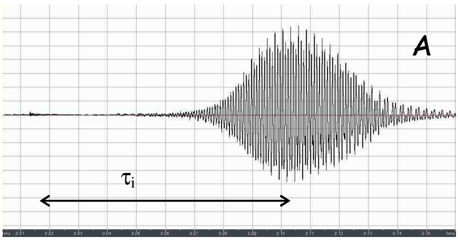

Figure 4. Staccato flute tone. τ_i indicates the time gap between key action and maximum tone amplitude.

tone) varied from 67-127 ms with an average of 94.5 ms (SD 18.0 ms). The duration of the staccato tones varied between 53 and 98 ms with an average of 78.8 ms (SD=11.8 ms). With a prescribed tempo of 132 bpm, the distance between eighth-note onsets should be 225 ms. Measured distance values from the analyzed tone to the next is on average 209.4 ms (SD=5.6 ms).

Spectral analyses indicate that the key action noise pre-excites the flute tube before the wind pressure produces the musical tone. The pre-excitation makes it easier to produce the correct pitch, as the expected partials are already present in the tube at a very low level.

CONCLUDING REMARKS

Data and computer technology has increased the possibility to get performance data in an easy way. It is still a challenge to establish reliable data acquisition systems and procedures, define system precisions, and evaluate data reliability.

In the evaluation of performance quality we may have to accept a number of equally ranked *families of phrasing and chord patterns* as aesthetically appreciated.

Acknowledgments

This work has partly been carried out at the Center for Music Experiments (CME) and Center for Research in Computing and the Arts (CRCA) at the University of California, San Diego, USA, and at the Acoustics Research Center (ARC) at the Norwegian University of Science and Technology (NTNU), Trondheim, as a part of the ongoing Performology Research Program at NTNU. The recordings have been done with a most impressive interest and contribution from professional and semi-professional performers. Thanks to all of them.

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References

Ortmann O. (1929). *The Physiological Mechanics of Piano Technique*. New York: Da Capo Press.

Repp B. H. (1999). A microcosm of musical expression: III. Contributions of timing and dynamics to the aesthetic impression of pianists' performances of the initial measures of Chopin's Etude in E major. *Journal of the Acoustical Society of America, 106*, pp. 469-478.

Tro J. (1998). Micro Dynamics Variation as a Measure of Musical Quality in Piano Performances. In S. W. Yi (ed.), *Proceedings of the 5th International Conference on Music Perception and Cognition* (pp. 367-373). Seoul, Korea: Seoul National University.

Tro J. (2000). Aspects of Control and Perception. Paper presented at the *3rd COST Workshop on Digital Audio Effects (DAFx00)*, Verona, Italy.

Tro J. (1999). Evaluation of performance precision in piano chords. Paper presented at the *Forum Acusticum, European Acoustical Association (EAA),* Berlin.

Tro J., Bjerkvik A., and Kristiansen U. (2003). Flute performology: Statistical analyses and numerical simulation of flute tone excitation. Paper presented at the *Stockholm Music Acoustics Conference (SMAC)*, Stockholm.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Assessing the importance of visual/theatrical features in the perception of music by an audience, using sociological tools

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This paper discusses the interaction of music with an audience, in the specific context of a live performance. This issue is tackled in two complementary directions. Firstly, I propose that musicians should look inside the theatrical universe to find new paths to perform music, especially the contemporary repertoire. This theatrical influence intends to expand the visual dimension of a performance into a more global and flexible perspective. Secondly, I propose the use of sociological methods of analysis to assess the audience's perception of those performances, thus emphasizing the natural context of its production and reception to collect data. The final aim of this study is to contribute towards closing the composer-audience gap, created by modernism in the twentieth century.

Keywords: contemporary music performance; theatricality; listeners' perception; sociological analysis

It is my conviction that musicians have a social and pedagogical responsibility. Indeed, it is the performers' task to search for new ways to *make* and to *take* music to people, even if that means challenging the traditional ways of music-making, leading them to experience sounds that they did not expect or even imagine that could exist. Yet this enterprising character is not new; there is a whole line of performers, such as David Tudor (1926-1996), Cathy Berberian (1925-1983), or Vinko Globokar (born in 1934), just to name a few that flourished after WWII, who not only repeated the "classical" canon of music-making but also searched for and experimented with new ways to make/take music to the listeners, especially when they were dealing with newly-made sounds.

Naturally, this adventurous spirit fits more easily with the contemporary repertoire, given that it can more easily accommodate new perspectives around music-making, allowing interpreters to stamp their personal ideas in a more creative manner. However, musicians usually play contemporary pieces as if they belonged to the Classic/Romantic repertoire. The way the instrument is played, the performer's attitude, as well as the stage presentation, repeats the same conventions fixed in three centuries of tradition. It is evident, though, that often the mere transmission of these sounds can be insufficient for a full understanding of the music by the audience. This can be confirmed by the distance that still exists between contemporary music and contemporary listeners (Menger 1983, 1986; Metzer 1983). To capture the spectators' attention to something unexpected is not an easy task for current performers. In order to contribute to reduce this distance I suggest exploring more deeply the visual dimension of a live concert, using the theatrical universe as inspiration.

As we all know, a live performance is not only a sonic event. It naturally provides visual information to the listeners which is absent in the CD/MP3 format. It was only in the 1990s that the visual component of expressive performances started being analyzed in a systematic way. These studies included the analysis of the performers' body movements (Davidson 1994, 1995), the gestures used to perform an instrument (Clarke and Davidson 1998), and the non-musical, expressive, or ancillary gestures (Davidson 1993, Wanderley *et al* 2005). Among other things, these experiments demonstrated that the visual information added by performer's actions was essential to convey expressive or emotional content and to engage the listeners.

Having this evidence as background, I propose to look inside the world of the theatre to find the *theatricality* of music making. That is, to expand the visual dimension of a musical performance to the entire stage, instead of circumscribing it just to the performer's actions or gestures. This represents the first aim of this paper. The second one stresses the importance of developing partnerships with sociologists, making use of their theories and methods for social analysis, to examine the audience's perception and reception to music so that the effectiveness of the musical communication might be assessed.

MAIN CONTRIBUTION

Theatricality in the music performance

According to the French theatre producer Antonin Artaud (1896-1948), *theatricality* embraces everything that is related to theatre with the exception of the dramatic text. It includes the staging, the scenery, the lighting, the costumes, and also the actors' gestures, expressions, movements, and moods. Theatricality deals essentially with the visual and spatial dimensions of the show; realms normally out of the sphere of action of instrumental music. Nowadays, musical performance cannot be conceived purely as a temporal art; instead, musicians must be conscious of its visual potentialities to attain more effectively their primordial intentions.

How can the theatrical universe *cross-fertilize* the musical performance? I propose three main points of intersection between them:

1. *Inner theatricality:* Adopting a performance style close to acting. That is, the player assumes another personality, as an actor/actress does, and performs music uniting body and spirit into a global expressivity. To attain this, the performer's expressive toolkit must include a whole spectrum of movements besides the instrumental ones, such as the non-musical gestures, the body postures, the facial expressions, breathings/ sighs, and glances.
2. *Outer theatricality:* Making use of the theatrical scenery techniques such as light design, scenario, costumes, and media.
3. *Mise-en-scène:* Entwining music performance into a narrative, where the performer has to make movements other than the musical ones, like speaking, walking, singing, dancing, or mimicking, in accordance with that narrative or script. This happens naturally when musical performance is included in a theatre play, a choreographic event or a cinematographic set. However, it can also take place in an orthodox musical concert, as happened in the 1960s and early 1970s inside the *avant-garde* movement called "music theatre" or "instrumental theatre."

This three-part division is, of course, artificial. It simply aims to illustrate more clearly the variety of elements that we can borrow from theatre to create new artistic achievements. From this point on, each musician must seek his/her own artistic answer, in accordance with various contingent factors such as the music's intention, the performer's ability or comfort to use different tools in his/her work, the technical facilities of a specific stage, and the expected audience.

Given that this enhancement of the visual and theatrical dimensions aims to attract people's attention to a careful and active listening of something outside the usual standards, the subsequent step is to search for the audience's feedback. To understand this, we must enter into the sociological world and make use of their methods to quantify and qualify their reactions (or non-reactions!).

Sociological analysis

The use of sociological methods to assess audience feedback to performances represents an uncommon strategy for analyzing musical events. The main reason for this choice comes from the fact that it envisages the musical phenomenon as it happens in its natural setting of production and consumption. This approach comes in line with the new paradigm that emerged among the sociologists of music, particularly in the late 1970s, which conceives "the music-society nexus in terms of the pragmatic contexts within which musical works take shape and come to have "effects" in real situations" (DeNora 2004, p. 38). This action-based paradigm opposes the score-based paradigm, mostly influenced by Adorno's ideas and theories (Adorno 1973), which regard music as something structurally analogous to social systems, structures, or norms (Becker 1995, Shepherd 2003). This concern with the "real world" context is also attracting interest from music psychologists, who are placing the social dimension at the core of their enquiries (Persson and Robson 1995, Davidson 1997, Hargreaves and North 1999, Thompson 2006, 2007).

There is, however, another reason to take a sociological angle to gauge musical phenomena. An audience is a group of people that experience a particular event in a specific time and place. Consequently, to study an "object" that is by essence fluid, multi-shaped, and ephemeral, we must use a multiplicity of methods to better adjust to each case. Therefore, the methodological agenda should include not only moment-by-moment analysis, such as local observation and the use of diaries, but also "post-concert" analysis to get more in-depth data, through questionnaires and semi-directive interviews with a representative group of individuals. Given that the sociological methodologies are extraordinarily wide and flexible, they allow the music researchers to embark upon a broad spectrum of questions associated both with the public's sociological profile (who are they?) and their receptivity to the artwork (how do they perceive it and express that perception?). These questions may help musicians to better understand the meaning of music in this global and postmodern era; an era that locates musical "meaning and even structure in listeners, more than in scores, performances, or composers" (Kramer 2002, p. 17). Hence, it is the time to bring listeners to the foreground of musical enquiries, emphasizing their creative involvement and showing how they may contribute to musical productions, which is similar to what happened in both literature and theatre (Jauss 1978, Bennett 1997). This shift of direction represents, undoubtedly, a challenge for all who deal with music in any way.

IMPLICATIONS

Primarily, this study intends to discuss the existence of other elements, besides the musical ones and consciously taken from the theatre, that are important for an effective communication of music to listeners in a live setting. Additionally, and given the fact that the performer-audience relationship is nowadays understood as bilateral, it will help us reflect on the artistic implications of the audience in the performer's work, an issue not much discussed until now. Ultimately, it can tackle more complex issues like the social role of art in our society. What is the current "place" of art inside a society completely saturated with all kinds of real and virtual stimulus? This looks to me like an intriguing question to pursue in the future.

Acknowledgments

I would like to thank all the persons that have generously contributed to this article, namely Dr. Daniela Coimbra for challenging me to attend this conference; Dr. Ana Vila Verde for her critical and always pertinent comments; Prof. Dr. João Teixeira Lopes for his encouragement and counseling on sociological and aesthetical issues; and, finally, Peter Blackburn and Marta Barbosa for their helpful revision of the manuscript.

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References

Adorno T. W. (1973). *Philosophy of Modern Music*. New York: Seabury.

Becker H. S. (1995). The power of inertia. *Qualitative Sociology, 18*, pp. 301-309.

Bennett S. (1997). *Theatre Audiences: A Theory of Production and Reception*. London: Routledge.

Clarke E. F. and Davidson J. W. (1998). The body in performance. In W. Thomas (ed.), *Composition—Performance—Reception: Studies in the Creative Process in Music* (pp. 74-92). Aldershot: Ashgate Press.

Davidson J. W. (1993). Visual perception of performance manner in the movements of solo musicians. *Psychology of Music, 21*, pp. 103-113.

Davidson J. W. (1994). What type of information is conveyed in the body movements of solo musician performers? *Journal of Human Movement Studies, 26,* pp. 279-301.

Davidson J. W. (1995). What does the visual information contained in music offer the observer? Some preliminary thoughts. In R. Steinberg (ed.), *Music and the Music Machine: The Psychophysiology and Psychopathology of the Sense of Music* (pp. 105-113). Berlin: Springer Verlag.

Davidson J. W. (1997). The social in musical performance. In D. J. Hargreaves and A. C. North (eds.), *The Social Psychology of Music* (pp. 209-228). Oxford: Oxford University Press.

DeNora T. (2004). Musical practice and social structure: A toolkit. In E. Clarke and N. Cook (eds.), *Empirical Musicology: Aims, Methods, Prospects* (pp. 35-56). Oxford: Oxford University Press.

Hargreaves D. J. and North A. C. (1999). The functions of music in everyday life: Redefining the social in music psychology. *Psychology of Music, 27,* pp. 71-83.

Jauss H. R. (1978). *Pour une Esthétique de la Réception.* Paris: Gallimard.

Kramer J. D. (2002). The nature and origins of musical postmodernism. In J. Lochhead and J. Auner (eds.), *Postmodern Music/Postmodern Thought* (pp. 13-26). New York: Routledge.

Menger P. M. (1983). *Le Paradox du Musicien.* Paris: Flammarion Harmoniques.

Menger P. M. (1986). L'oreille speculative: consommation et perception de la musique contemporaine. *Revue Française de Sociologie, 27,* pp. 473-475.

Metzer H. K. (1983). La musique dans la societé de divertissement. *Interface/Journal of New Music Research, 12.*

Persson R. S. and Robson C. (1995). The limits of experimentation: On researching music and musical settings. *Psychology of Music, 23,* pp. 39-47.

Shepherd J. (2003). Music and social categories. In M. Clayton, T. Herbert, and R. Middleton (eds.), *The Cultural Study of Music: A critical introduction* (pp. 69-79). London: Routledge.

Thompson S. (2006). Audience responses to a live orchestral concert. *Musicae Scientiae, 10,* pp. 215-244.

Thompson S. (2007). Determinants of listeners' enjoyment of a performance. *Psychology of Music, 35,* pp. 20-36.

Wanderley M. M., Vines B. W., Middleton N., *et al.* (2005). The musical significance of clarinetists' ancillary gestures: An exploration of the field. *Journal of New Music Research, 34,* pp. 97-113.

Thematic session:
Practicing performance

International Symposium on Performance Science
ISBN 978-90-9022484-8

Unresolved dissonance? Subjectivity in music research

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Psychologists want to know about musical expertise for two reasons. First, expert music performance is one of the highest human accomplishments, combining body knowledge, memory, and creativity in a way that very few other achievements can match. Second, knowledge of how musical expertise develops and how it works in real-time performance could be useful to musicians themselves. To that end, our research group has developed unique methods that integrate the perspectives of researcher and performer. However, researchers and performers tend to have different personal standpoints, ways of thinking, and goals. When psychologists and performers work together to understand musical expertise, these differences need to be addressed and the inevitable conflicts must be resolved.

Keywords: subjectivity; research methods; musical expertise; performance cues; musical memory

Psychologists want to know about musical expertise for at least two reasons. First, simply because it is one of the highest human accomplishments, combining body knowledge, memory, and creativity in a way that very few other human achievements can match. Second, because knowledge of how musical expertise develops and how it works in real-time performance could be very useful to musicians themselves.

What do musicians know? A musician's skills are the result of thousands of hours of practice. At least 10,000 hours, by some estimates, are required to perform at an expert level in any domain, be it baseball, chess, medical diagnosis, or figure skating. One problem for the researcher is that by the time the performer has become an expert, much of what she or he does is automatic. So that just asking the expert, "How do you do X?" is unlikely to yield a very useful answer. For example, Rajan Mahadevan earned a place in the *Guinness Book of Records* by reciting the first 31,811 digits of pi (Π) from memory. When asked how he did it, he said that he just fixated on each number. When pressed for details, he said that being asked to describe how he memorized number sequences was like being asked to describe how he rode a bicycle. He was sure that he knew how to do both, but found it hard to describe how (Thompson *et al.* 1993). Often, the expert is so familiar with the task that he or she can no longer easily analyze and describe the "building blocks" that the novice needs.

Another problem with asking the experts is that performers may be anxious, defensive, or unaware of what they do. The life of a performing artist is stressful, and performers have been known to engage in superstitious strategies for dealing with anxiety-producing events. Moreover, the performer may not want others to know about this anxiety and these personal strategies. For example, published interviews with master pianists on their memory strategies and problems reveal a variety of conflicting views that probably reflect mixed motives about self-disclosure (Chaffin *et al.* 2002).

Self-report, in the form of interviews and reflection, is not enough. Musicians, when asked straightforwardly, do not always give us the kind of detailed and consistent answers that would satisfy psychological researchers or help other musicians do their work better. Sometimes they can and sometimes they cannot. How then to tell which reports to trust? Our research methods were devised to combine the musical insights of an experienced performer with the objective methods of a cognitive psychologist. The performer's insights give meaning to the behavioral data of the scientist; the behavioral data tests and validates the performer's insights.

MAIN CONTRIBUTION

The method we devised requires individual musicians to record their practice while learning a new piece and then to report all musical features that they thought about as they practiced, every decision that they made about technique, interpretation, musical structure, or performance (Chaffin *et al.* 2002). Figure 1 provides an example from a report of bowing decisions made by cellist Tânia Lisboa (Lisboa *et al.* 2006).

We ask the musicians to report on every aspect of the music that they think is important. Typically, they report decisions about technique, interpretation, performance cues, and musical structure. The reports are made after the piece has been learned, which is typically many weeks or months after practice begins. How do we know whether the musician remem-

Figure 1. Bowing decisions for the *Prelude* from J. S. Bach's *Suite No. 6* for solo cello, reported by cellist Tânia Lisboa who marked places where she had to think about bowing with arrows (highlighted here for better visibility).

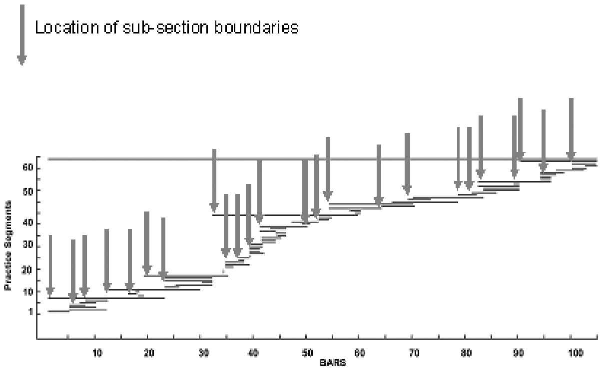

Figure 2. The practice graph showing where the cellist started and stopped reads from bottom to top with each horizontal black line representing continuous playing of the bars shown below. Arrows represent beginnings of sub-sections reported by the cellist.

bers correctly? We compare the reports with what the musician did in practice. Figure 2 shows the practice record for session 15 in the *Prelude* study. The black, horizontal lines record what the cellist *did*. You can see that she was consistently starting and stopping in some places and not others. What was special about these places? The vertical arrows represent what she *said* 20 months later when reporting the location of the subsections of the musical structure. You can see that she was starting and stopping at the subsection boundaries. This correspondence between what she did in practice and what she later reported both validates her report and helps us to understand the behavioral record of what she did in session 15.

You can see that she ended the session by playing through the piece without interruption, her first performance from memory. So we can see that in preparing to play from memory she was setting up a mental map of the piece in which beginnings of subsections provided the main landmarks.

We call these landmarks *performance cues*. Performance cues provide a mental map that the musician is able to monitor as the music unfolds to keep track of where she is and ensure that critical aspects of the performance go as planned, e.g. a critical fingering or bowing (Chaffin *et al.* 2002, Chaffin and Logan 2006). Performance cues give the musician conscious control of the highly practiced motor sequences which would, otherwise, be entirely automatic. They are created by repeatedly attending to a particular feature of the music during practice so it comes to mind automatically during performance, eliciting from memory the sounds, feelings, thoughts, and actions that have been linked with it during practice. In Figure 2, we see the cellist setting up performance cues for musical structure.

Experienced performers use various types of performance cues to represent the different aspects of the music they have to keep track of: expressive turning points, interpretive gestures, and key points of technique. Performance cues allow the musician to attend to some aspects of the performance while allowing others to be executed automatically. In this way, they allow the performer to remain mindful of a memorized performance that might otherwise become mechanical through extended practice.

Although our methods have proven fruitful, they also create problems of meaning and interpretation. Think for a moment about the subjectivity, the personal identity, core beliefs, and values of a professional pianist and a cognitive psychologist. In terms of personal epistemology, the performer is likely to be somewhat sceptical about scientific methods. He or she is likely to have a great deal of respect for individuality, creativity, and the mystique of art, and to doubt that aesthetics can be measured with the psychologist's methods. As a thinker, the performer may rely on intuition more than logic, especially in the performance realm. The performer desires to be viewed as unique, not like others. The researcher, on the other hand, is likely to be invested in empiricism and to believe in the value of systematic description of behavior from an outsider's perspective. Underlying the researcher's use of quantitative analysis is a belief in lawful regularities in the physical and social world, a faith in the possibility of predicting and understanding human behavior. To that end, the psychologist tends to rely on objective records of behavior and to accept an implicit hierarchy between researcher and subject in which the researcher is higher in status and expertise. In contrast to the performer's desire to be viewed as unique and creative, the researcher's desire is to be viewed as objective and scientific.

When a researcher and a performer join forces, there are also practical considerations based on their different social positions. For the performer, there is little personal payoff for hours spent in research, as opposed to hours spent in repertoire building, performing, teaching, and recording. The performer has no institutional supports for research (office, computers, staff). The performer's income varies based on opportunities for public performance. For the researcher, in contrast, research and publication are the keys to professional stature. He or she is likely to have institutional support and institutional rewards for publishing research. His income is fixed and, once tenured, secure.

Perhaps most important, the goals of the researcher and the performer might differ substantially as they embark on the same project. The first performer we studied, for example, described her goals as follows: to better understand her own process of memorizing for performance, to make her practice time more efficient, to reduce the possibility of memory failure on stage, to improve her teaching, and to pass on the knowledge gained to other pianists. The chief researcher, on the other hand, described his goals as follows: to understand memory expertise in a new domain, to contribute to basic scientific knowledge, and to solidify his professional stature through high-quality research.

IMPLICATIONS

Our research group has devised novel and fruitful methods for integrating the perspectives of highly skilled musicians with the perspectives of psychological researchers. Nevertheless, these methods bring with them the possibility of miscommunication and the necessity for recognizing the different standpoints of the performer and the researcher. Our research group has found it possible—indeed necessary—to agree on three principles that have kept us grounded and made our work possible despite our differences.

The first is s*elf-reflexivity,* by which we mean that we engage in a continuous process of reflection on our own assumptions, motives, and epistemological starting points.

The second is s*trong objectivity*. We acknowledge that the subjectivity of both the performer and the psychologist inform every aspect of the research. Each member of the research group makes an ongoing effort to understand these effects (both positive and negative) rather than try to hide them behind a rhetoric of scientific objectivity or artistic uniqueness.

Finally, we value *methodological plurality*. We attempt to remain open to all methods, without assuming that any one method is more important or more valuable than others. The “insider’s” perspective from the performer and the “outsider’s” perspective from the researcher are both essential. The utility of our method lies in comparing and integrating the two.

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References

Chaffin R., Imreh G., and Crawford M. (2002). *Practicing Perfection: Memory and Piano Performance*. Mahwah, New Jersey, USA: Erlbaum.

Chaffin R. and Logan T. (2006). Practicing perfection: How concert soloists prepare for performance. *Advances in Cognitive Psychology*, *2*, pp. 113-130.

Lisboa T., Chaffin R., Logan T., and Begosh K. T. (2006). Action, thought, and self in cello performance. Invited symposium presentation in R. Chaffin (chair), *Longitudinal Case Studies of Preparation for Musical Performance,* International Conference on Music Perception and Cognition (ICMPC), Bologna, Italy.

Thompson C. P., Cowan T. M., and Frieman J. (1993). *Memory Search by a Memorist.* Hillsdale, New Jersey, USA: Erlbaum.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Variability and automaticity in highly practiced cello performance

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Performance cues are the landmarks of a piece of music that a performer attends to during performance. While most aspects of a performance become automatic with practice, performance cues provide the musician with a means of conscious control of otherwise automatic motor sequences. Experienced performers strategically select the performance cues that they need to attend to during performance in order to achieve the musical and technical effects that they want. Previous evidence for this claim has come from practice and recall. This study examined effects of performance cues on live and practice performances. We recorded the practice and public performances of an experienced cellist learning the *Prelude* from J.S. Bach's *Suite No. 6* for solo cello over a two-year period. We measured bar-to-bar fluctuations in sound-level and tempo for 8 practice, 7 live, and 12 "lab" performances, the latter played with exaggerated, normal, or minimal expression. Expressive and interpretive performance cues were consistently associated with slower tempi and lower sound-levels. These effects were larger in exaggerated than in minimally expressive lab performances, and there were similar differences between the live performances. The effects suggest performance cues provide a way of controlling highly practiced performance.

Keywords: performance; expression; interpretation; memory; practice

Performance cues are the landmarks of a piece of music that a performer attends to during performance (Chaffin *et al.* 2002, Chaffin and Logan 2006). While most aspects of a performance become automatic with practice, performance cues provide the musician with a means of conscious control of otherwise automatic motor sequences. Experienced performers strategically select the cues that they need to attend to during performance in order to achieve the musical and technical effects that they want. Previous support for this claim has been indirect, based primarily on evidence from practice and free recall of the score. This study examined effects of performance cues on live and practice performances.

An experienced cellist learned the *Prelude* from J.S. Bach's *Suite No. 6* for solo cello. We recorded all practice and public performances for two years and examined them to see whether we could identify musical gestures corresponding to interpretive and expressive performance cues reported by the cellist.

METHOD

Participant

Tânia Lisboa was trained in classical cello and piano in Brazil, England, and France, and performs regularly as a cello soloist.

Materials

The *Prelude* from J.S. Bach's *Suite No. 6* for solo cello explores both the mellow quality and virtuoso aspects of the instrument.

We examined public performances (n=7), polished practice performances starting the day before the first public performance (n=8), and 12 "lab" performances done at the time of the later live performances. In the lab performances, the cellist performed for small audiences with exaggerated (n=2), normal (n=6), or minimal expression (n=4).

Procedure

The cellist video-recorded her practice and public performances from the first time she sat down with the *Prelude* until the eighth public performance 92 weeks later. The total time spent in practice was approximately 34 hours.

The cellist reported all the decisions she made about technique, interpretation, and performance by marking them on copies of the score. Of concern here are her reports of performance cues for musical structure, expression, interpretation, intonation, and three types of cues for basic technique: cues for right hand (bowing and changing strings) and left hand (fingering and hand position).

We measured half-bar to half-bar fluctuations in sound-level and tempo for the 27 performances. Factor analysis grouped similar performances together. Regression analyses identified fluctuations in tempo and sound-level that were related to performance cues. Analyses of variance compared these effects across performances.

RESULTS

Factor analysis identified two factors for both tempo and sound-level. One factor was interpreted as reflecting expressivity; the heaviest loadings were for extra-expressive lab performances and lowest loadings were for non-expressive lab performances. The second factor was interpreted as reflecting the tension felt by the cellist about the performance; the highest loadings were for the first two non-expressive lab performances, which the cellist found very difficult, and the lowest loadings were for practice performances, in which the cellist would have been more relaxed. Consistent with these interpretations, Figure 1 shows that decreases in tempo were more closely aligned with expressive performance cues for factor 1 (expressive performances) than for factor 2 (tense/non-expressive) performances.

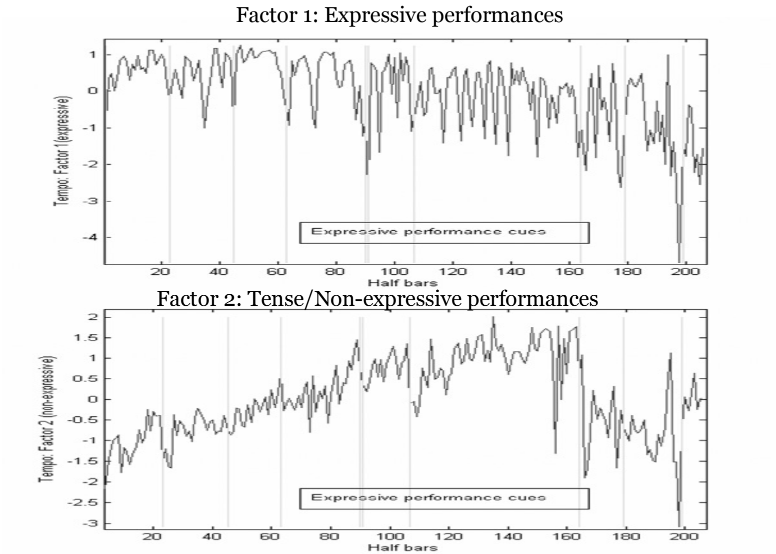

Figure 1. Factor scores representing tempo (per half-bar) for expressive (Factor 1, top panel) and tense/non-expressive (Factor 2, bottom panel) performances. Vertical lines showing the location of expressive performance cues correspond with tempo minima more closely for factor 1 than for factor 2.

Table 1. Regression coefficients for effects on *tempo* of predictors representing performance cues and other musical properties, and *F* values for differences between factors in the size of the effects.

	Factor 1 (expressive)	*Factor 2 (tense)*	*Differences (F)*
Performance cues			
Expressive intensity	-0.19**	-0.16*	0.04
Expressive perf. cue	-0.39***	0.07	21.53***
" " " : serial position from	-0.18**	0.60***	52.74***
Interpretive perf. cue	-0.25***	-0.00	5.77**
" " " : bar before	-0.06***	-0.01	0.35
" " " : serial position from	-0.28***	0.43***	42.39***
Intonation perf. cue	-0.16	-0.17	0.00
" " " : serial position from	0.37***	-0.02	4.80*
Bowing perf. cue	-0.13	-0.04	0.64
Other musical properties			
Phrasing	-0.23*	-0.02	1.36
" ": serial position from	-0.11	-0.20*	0.26
Phrase repeated (switch)	0.11*	0.05	0.43
R^2	0.56***	0.58***	

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Regression analyses showed that expressive performance cues were consistently associated with slower tempi (Table 1) and lower sound-levels (Table 2). The effect for tempo was larger for expressive (factor 1) than for tense performances (factor 2), and this difference was statistically reliable.

The effects show that the correspondences between expressive performance cues and tempo that are apparent in Figure 1 (top panel) were significant. Similar comparisons (not presented here) between the different types of lab performance showed similar differences. These effects support the interpretation of factor 1 as representing expressive performances and factor 2 as representing tense (less expressive) performances.

There were additional reliable differences between the two types of performance (see Tables 1 and 2, column 4). For tempo, the differences were confined to performance cues (Table 1). For sound-level most of the differences were for other musical properties. Performance cues were responsible for *some, but not all,* of the reliable differences between the performances.

Table 2. Regression coefficients for effects on *sound-level* of predictors representing performance cues and other musical properties, and *F* values for differences between factors in the size of the effects.

	Factor 1 (expressive)	*Factor 2 (tense)*	*Differences (F)*
Performance cues			
Expressive intensity	0.21**	0.02	2.83~
Express. cue: serial pos. from	0.19**	-0.13~	10.02**
Inter. cue: serial pos. from	0.01	-0.17*	3.34~
Fingering/hand pos. perf. cue	-0.18*	-0.03	1.72
Other musical properties			
Dynamic level (e.g. *p*, *f*)	0.41***	-0.12	27.72***
Dynamic change (e.g. *cresc.*)	0.19**	0.05	2.48
Phrasing	-0.02	-0.36**	4.13*
Phrasing: 2nd ½-bar in phrase	0.12	-0.16~	5.03*
Phrasing: serial position	0.10	-0.42***	10.05**
Switch: bar before	0.16**	-0.02	4.33*
Technical difficulty rating	-0.02	0.39***	7.49**
R^2	0.47***	0.42***	

* p<0.05, ** p<0.01, *** p<0.001

DISCUSSION

Performance cues were systematically related to fluctuations in tempo and sound-level, complementing similar findings by Chaffin *et al.* (2007). The earlier results appeared, however, to reflect the performer's desire to avoid wrong notes, whereas the present effects appear to be due to musical interpretation. The results support the suggestion that musicians use performance cues to achieve their interpretive and expressive goals in performance.

The effects of performance cues differed across performances. The differences support the claim that performance cues provided the musician with control of the automatic motor sequences involved in performance. In the lab performances, the effects on tempo of expressive and interpretive cues were consistent with the cellist's goals of playing with exaggerated, normal, or minimal expression. Decreases in tempo at these cues were bigger in extra-expressive performances and smaller in non-expressive performances. Similar differences between the two factors suggest that similar variation in musical intention were present in other performances and, thus, that spontaneous differences between performances were attributable to performance cues. The differences between the two factors suggest that performance cues provided the musician with control of the automatic motor sequences required for performance.

For tempo, all the statistically reliable differences between performances were attributable to performance cues. There were no reliable differences due to other musical properties. For sound-level, in contrast, most differences between performances involved other musical properties. These results show that some reliable differences between performances are due to performance cues, while others are due to musical properties that are not encoded in memory by performance cues. Performance cues are responsible for *some, but not all,* differences between repeated performances of the same piece.

Acknowledgments

We thank the following research assistants for help in making the tempo and sound-level measurements: Susan Barb, Brendan Eckert, Johnathon Ericson, Kyle Feliciano, Vica Mehta, Toby Napoletano, Kristen Rains, Enid Shu, Nigel Stepp.

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References

Chaffin R., Imreh G., and Crawford M. (2002). *Practicing Perfection: Memory and Piano Performance*. Mahwah, New Jersey, USA: Erlbaum.

Chaffin R., Lemieux A. F., and Chen C. (2007). "It's different each time I play": Spontaneity in highly prepared musical performance. *Music Perception*, *24,* pp. 455-472.

Chaffin R. and Logan T. (2006). Practicing perfection: How concert soloists prepare for performance. *Advances in Cognitive Psychology, 2*, pp. 113-130.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The effect of retrieval cues developed during practice and rehearsal on an expert singer's long-term recall for words and melody

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We examined a singer's recall for the words and melody of a work with small ensemble and investigated the extent to which this was predicted by practice and rehearsal 18, 32, and 42 months earlier. The singer video-recorded nine practice/rehearsal sessions with the conductor as accompanist over four weeks. She subsequently noted the locations of decisions made during practice (musical features) and those that were retained as cues for retrieval when the piece was performed (individual and shared performance cues). Regression analysis showed that these determined the nature and amount of practice and rehearsal. Crucially, distance from musical features and performance cues also affected recall, suggesting that different kinds of practice influence the way they function as "landmarks" and "triggers."

Keywords: landmarks; memory; performance; singing; triggers

The longitudinal case study method is used to investigate the development of performers' mental representations for music. One key aspect of the formation of mental representations is the development of performance cues. These are the basic, interpretive, and expressive features of the music to which the musician pays attention during practice and rehearsal and which, as a result, become "landmarks" when the piece is performed. This has been investigated through a number of case studies, involving the analysis of solo performers' video-recorded practice sessions, verbal commentaries, and post-performance annotation of musical scores. Participants to date have included a classical pianist (Chaffin *et al.* 2002), a jazz pianist (Noice *et al.* 2004), and a cellist (Logan *et al.* 2007).

Although long-term recall has been studied for many years there have been comparatively few investigations of long-term recall for music. The present study extends the first author's research on singers' learning and memorization of the words and melodies of songs (Ginsborg 2002, Ginsborg and Sloboda 2007). It also builds on a study of the development of an expert singer's and conductor's shared performance cues in the course of individual practice and collaborative rehearsal based on a content analysis of talk cross-referenced with post-performance annotations of the musical score (Ginsborg *et al.* 2006a, 2006b). Its aims were to examine the singer's long-term recall for the words and melody of Stravinsky's *Ricercar 1*, for soprano and small instrumental ensemble, 18, 32, and 42 months after performance from memory, and to investigate the extent to which this was predicted by practice.

METHOD

Participants

Jane Ginsborg, the first author, is a former professional singer; she has worked with the pianist and conductor George Nicholson for more than 30 years, performing as a duo and as members of a variety of ensembles.

Materials

Ricercar 1 (c. 4 minutes), for solo soprano and ensemble, is from Stravinsky's *Cantata* for two solo singers, women's choir, and small instrumental ensemble.

Procedure

Towards the end of 2003 the singer video-recorded five individual practice sessions (4 hours, 13 minutes) and four joint rehearsals (2 hours, 47 minutes) with the conductor. Three ensemble rehearsals (57 minutes) were not recorded or analyzed. A public performance of the complete *Cantata*, conducted by George Nicholson, with the first author as solo soprano, was given on 16 December 2003.

Soon after this performance the participants annotated multiple copies of the musical scores, independently, to show their understanding of the formal structure of the piece, features requiring basic, structural, and interpretive decisions during rehearsal, and musical "landmarks" used as individual performance cues (PCs). They then discussed and reported the landmarks they had used as shared performance cues (SPCs).

The singer wrote out one free recall during the preparation period, gave four complete performances from memory, and made several further written free recalls subsequent to the performance before each period of work on data analysis, writing up, or presenting this project. The first free recall (FR1) was made between the last two rehearsal sessions (words and rhythms only). In the course of the penultimate rehearsal, the singer and conductor, playing the piano, gave two uninterrupted performances of the piece. The singer made one error in one performance and two errors in the other (99.6% and 99.2% accuracy, respectively). The final rehearsal included an uninterrupted performance in which the singer accommodated to two errors made by the conductor. The public performance was accurate in all respects.

The singer made seven further free recalls after the public performance. In each case she wrote down as much as she could remember of the words and melody. The versions she notated were then compared with the score. The fifth free recall, in June 2005, was the first to yield more than one or two trivial errors (FR2). In August 2006 and June 2007, 32 and 42 months after the performance, the singer made and analyzed two more free recalls (FR3 and FR4).

RESULTS

The musical features and performance cues noted by the singer were used as predictor variables in a regression analysis to determine their effects on her behavior (see Table 1).

Errors were analyzed in practice and rehearsal and in the four free recalls. In FR1, words and rhythms were notated with 92% accuracy. Most errors (70%) concerned the recall and notation of rhythms. In FR2 there was a significant decrease in recall (t=5.47, p<0.0001): 75% of the piece was recalled correctly. Around half the errors (44%) involved omitting the words while preserving the melody, and 46% involved omitting the words and melody altogether. In FR3, there was a very slight, non-significant decrease in recall: 72% of the piece was recalled correctly. Errors included durations (21%), forgetting the words but preserving the pitch if not the rhythmic/durational components of the melody (28%), and forgetting both words and melody altogether (51%). There was a further, near-significant, decrease in recall in FR4 (t=1.87, p=0.06): 66% of the piece was recalled correctly. The majority of errors were durations (26%), forgetting the melody but preserving the words (12%), and omitting words and melody simultaneously (57%).

Table 1. Effects of predictor variables on singer's behavior during practice.

Type of feature/ PC	*Predictor variable*	*Sessions 1-3, 5 (singer alone)*	*Session 6 (with conductor)*	*Session 8 (singer alone)*	*Sessions 9, 12, 15 (with conductor)*
Structur.	Start section	S 0.29***	S 0.35***	S 0.25***	S 0.44***
	Switch			R -0.16*	R -0.15*
	Start phrase	R 0.18* S 0.63*** P -0.17*	S 0.23*	S 0.47***	S 0.16*
Basic	Prepare	S 0.30***		R 0.21* S 0.23**	P 0.15*
	Words	R 0.14*		R 0.20**	R 0.15*
	Breath/Tech.		P 0.16*	R 0.23**	
Interpret.	Words (meaning)				R 0.16*
Express.	Express.	S -0.17***	P 0.20*		
Basic PC	Prepare PC	S -0.18**		R -0.29** S -0.17*	
	Tech. PC			S 0.13*	
Interpret. PC	Words PC		R -0.34***	R -0.32***	R -0.30**
Basic SPC	Arrival/off SPC	P 0.38***	P 0.40***	P 0.59***	P 0.30***
Express. SPC	Express. SPC		S -0.22*		
R^2	Repetitions			0.14**	
R^2	Starts	0.62***	0.25***	0.42***	0.21***
R^2	Stops	0.20***	0.22***	0.37***	0.12***

*** $p<0.001$, ** $p<0.01$, * $p<0.05$

Regression analyses showed the extent to which accuracy could be predicted by serial position (distance) from structural features and performance cues as predictor variables and (a) accuracy in practice and rehearsal and (b) the four free recalls as criterion variables (see Table 2).

DISCUSSION

The significant effects of the predictor variables on the singer's starts, stops, and repetitions during practice and rehearsal establish the validity of the reports. Thus, structural features predicted behavior in all groups of sessions: positive effects indicate, for example, that practice segments were more likely to begin at the starts of sections. Negative effects indicate starting or stopping

Table 2. Effects of serial position from predictors on accuracy during preparation for performance and free recall.

Type of feature/PC	*Predictor variable: Serial pos. from*	*Accuracy during practice and rehearsal*	*Free recall 2 (June 05)*	*Free recall 3 (August 06)*	*Free recall 4 (June 07)*
Structur.	Start section				-0.20**
	Switch		-0.24***	-0.21**	
	Start phrase	0.26***			
Basic PC	Tech. PC		0.37***	0.14*	
Basic SPC	Score SPC			0.38***	
	Arrival/off SPC			0.15*	0.20**
Express. SPC	Express.SPC		0.15*	-0.24***	
R^2		0.10**	0.15***	0.24***	0.16***

*** $p<0.001$, ** $p<0.01$, * $p<0.05$

around (either before or after) rather than *at* the specific location of a feature or cue, thus enabling it to be rehearsed in context. While structural and basic features predicted behavior throughout the sessions, a progression can be noted from behavior predicted by basic performance cues in the early individual practice sessions to behavior predicted by interpretive performance cues in the sessions with the conductor. It is worth noting that the singer recalled a high proportion of the piece correctly, 18, 32, and 42 months after the performance given in December 2003. Analysis of the effects on errors in free recall of serial position from features and performance cues, however, suggest that they function as *landmarks* and *triggers*. Landmarks are the locations of features and cues at which there are negative serial position effects. Recall is best at the landmark and worsens with increasing distance. Triggers are features and performance cues producing positive serial position effects, indicating that recall is worst at the trigger but improves with increasing distance. As predicted from earlier research, structural features functioned as landmarks in all three recalls while performance cues—basic, individual, and shared—functioned as triggers. It may be that the individual "technical" performance cues operated at a procedural level. When the singer was actually performing, singing aloud, the cue related to a physical motor activity; when she wrote out what she remembered of the words and melody, the cue itself was not remembered as it had been in performance. Similarly, the shared performance cues related to coordination with the conductor. In the absence of the other musician, memory at the location of the cue was poorer than memory for what followed. We would argue that landmarks relate to the explicit recall of declarative knowledge demonstrated by the ability to write out the melodic line of the score after as long a period as three and a half years. Triggers, conversely, relate to the implicit recall of procedural knowledge, which should be easier to demonstrate in live performance.

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References

Chaffin R., Imreh G., and Crawford M. (2002). *Practicing Perfection: Memory and Piano Performance*. Mahwah, New Jersey, USA: Erlbaum.

Ginsborg J. (2002). Classical singers memorising a new song: An observational study. *Psychology of Music, 30*, pp. 56-99.

Ginsborg J. and Sloboda J. (2007). Singers' recall for the words and melody of a new, unaccompanied song. *Psychology of Music, 35*, pp. 419-138.

Ginsborg J., Chaffin R., and Nicholson G. (2006a). Shared performance cues in singing and conducting: A content analysis of talk during practice. *Psychology of Music, 34*, pp. 167-194.

Ginsborg J., Chaffin R., and Nicholson G. (2006b). Shared performance cues: Predictors of expert individual practice and ensemble rehearsal. In M. Baroni *et al.* (eds.), *Proceedings of the 9th International Conference on Music Perception and Cognition*, Bologna, Italy.

Logan T., Begosh K., Chaffin R., and Lisboa T. (2007). Memorizing for cello performance. Paper presented at the *Annual Meeting of the Society for Music Perception and Cognition 2007*, Concordia University, Montreal, Canada.

Noice H., Chaffin R., Noice A., et al. (2004). Specifying the flexible mental representation used in jazz improvization. Poster presented at the *Psychonomic Society*, Minneapolis, Minnesota, USA.

Thematic session: Performance Analysis I

International Symposium on Performance Science
ISBN 978-90-9022484-8

Performance motives: Analysis and comparison of performance timing repetitions using pattern matching and Formal Concept Analysis

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A method combining a pattern-matching approach with Formal Concept Analysis is used to explore repeated timing patterns in performance in order to analyze characteristics of performances and differences among them. Initial analysis of timing data from performances of Chopin's Etude Op. 10, No. 3 suggests that repetitions in timing patterns occur in several contexts: with motivic material identifiable in the score, with the same structural positions, in parts played very quickly, and not directly coinciding with any of the above. The paper explores the relation between these contexts and the roles of such repetitions in different performances of the same piece.

Keywords: music information retrieval; performance; pattern matching; repetition; motive

Investigations of performance often make primary reference to the score, using structural and other score-derived information to predict and explain performance features. Furthermore, averages of one or more groups of performances have been often regarded as representative. In this study, we concentrate on two aspects that are difficult to explore on these bases. We investigate the types of relationship between patterns of performance "features" and those in the score and their frequency, and similarities and differences among recorded performances of the same piece. We do so on the basis of recurrent expressive features that, we argue, have a "motivic" function in given performances. Motives (short repeated melodic, rhythmic, harmonic patterns) have long been recognized as important elements of musical structure (Réti 1961). We develop this by exploring repeated patterns of expression originating in performance, which we term "performance motives." Here we investigate repetitions of performance timing patterns in recorded performances of Chopin's Etude Op. 10, No. 3 for piano.

The Etude is in ternary form: A—bars 0^4-21^2, B—bars 21^3-61, A'—bars 62-77. Bars 1-5 are exactly repeated in bars 9-14, and bars 9-19 are exactly repeated in bars 62-72. Performances of this piece have been analyzed from a number of perspectives. For example, in Rink's (2004) analysis of the Etude, recorded performances are studied, as are interpretative possibilities other than those heard within the recordings. Furthermore, Repp (1998) analyzed performances of bars 1-5 of the piece using principal component analysis and identified at least four dominating "independent 'timing strategies'" that could be related to the melodic-rhythmic grouping structure of the music and local emphasis, and others that do not seem to represent an alternative structural interpretation of the music but rather an alternative "gestural shaping." The timing patterns could be described as a weighted combination of these strategies and idiosyncratic variation, and a wide range of basic tempos and of degrees of tempo modulation were identified.

The aims of this paper are (1) to explore and characterize expression in performance through "performance motives" primarily by searching for repeated timing patterns in the individual performances and (2) to compare performances of the same piece using the identified motives.

METHOD

The method has three stages: quarter-note beat-timing extraction, pattern matching, and lattice generation. Timing information from ten recorded performances of the Etude spanning 1933-2001 was collected and automatically corrected by manually tapping to the onsets of notes occurring on each eighth-note beat using Sonic Visualiser. A pattern-matching approach and Formal Concept Analysis (Ganter and Wille 1999) were used to identify repeated timing patterns using a tool developed in TurboDelphi™ for pair-wise comparisons of groups of quarter-note beats. It executes multiple analyses enabling concentration on different group sizes, degrees of similarity, and global comparison within and among performances. Formal Contexts were produced for each performance, and the Con Exp package produced line diagrams showing pairs of repetitions that can be linked to other repeating units. Following perceptual studies, a 60 ms threshold was used, below which two notes were deemed the same length (Moore 1997).

RESULTS

The results indicate that there are differences between the performances in the number of repeated units, their repetitions, and tempo fluctuations. The extremes of the trends are Szekely (1987), with a very steady tempo and many repetitions, and Cortot (1933), with far fewer ones, while Ashkenazy (1967) is in-between. These are used as examples in the following discussion and are referred to by the performers' names.

Repetition types

Repetitions in timing patterns were identified in several contexts.

Type 1: Repeated timing patterns occurring with exact or varied motivic repetitions identifiable in the score and in the same structural positions

This type can be predicted from previous literature (Friberg and Battel 2002). However, in the performances the size of the repeated units varies. For example, in the Cortot recording the pattern of bars 1^2-2^2 and 2^4-4^2 is repeated in bars 9^2-10^2 and 10^4-12^2, encompassing a large proportion of the first phrase and its repeat. The span of similarity is shorter in the repetition at bars 62-66, occurring only in bars 12^2-13^2 and 65^2-66^2. In Szekely's performance, however, bars 9^1-10^4 and 62^1-63^4 have the same patterns, whereas in Ashkenazy's there is even less coincidence between the repetitions identified in the score and the repeated timing patterns. For example, an exact repetition of bars 2^4-3^4 occurs at bars 63^4-64^4 but not in bars 9-13. In none of the performances do exact timing repetitions coincide with all repetitions identified in the score, suggesting that timing repetitions of units may be related to their position in the piece more generally and not solely to score-based motives. Varied repetitions identified in the score in some cases coincide with exact timing pattern repetitions. The units of varied repetition are relatively short. In some cases, varied repetitions identified in the score follow exact ones, and some or all share repetitions of the same timing pattern (for example, in bars 18^1-18^4, 71^1-71^4, and 72^1-72^4 of the Cortot, and for the Ashkenazy in bars 17^2-18^1 and 18^2-19^1).

Type 2: Repeated timing patterns occurring in the same structural positions but where different motivic material is identifiable in the score

Theories of structural perception predict systematic timing variation at structural positions such as phrase ends or bar starts. Therefore, it could be expected that repeating structural patterns identifiable in the score would be reflected in the timing patterns. The results indicate that such repetitions occur with devices like phrase-final lengthening or the emphasis of strong beats in the bar. For example, in the Cortot, the timing pattern of bars 10^3-11^2 is repeated in bars 62^3-63^1; the beat location in the bar is the same but the locations in the opening theme are different.

Type 3: Repeated timing patterns during passages of relatively quick tempo

The B section has continuous eighth-notes and many performers play it much more quickly and steadily than the A sections (particularly bars 38-53). There are many timing repetitions here that may be considered distinct from those in the slower and rhythmically more varied A sections. For example, in the Szekely, the eighth-note lengths of bars 30^1-34^4 are repeated in bars 34^1 and 38^4. This coincides with the repetition of the whole four-bar phrase. For the Cortot, bars 46^4-49^1 are repeated in bars 49^4-52^1, at a metrically equivalent position. Therefore, many repetitions in the B section coincide with motives or phrases identifiable in the score or occur in structurally similar areas.

Type 4: Repeated timing patterns not related specifically to the above characteristics

Some timing repetitions do not relate so specifically to any of the above characteristics. For example, in the Ashkenazy, the timing patterns of bars 7^1-7^4 are repeated in 59^4-60^3. Though these have different metrical positions, both occur during the two bars preceding the return of the opening theme: the first on a syncopated first beat and the second on the upbeat. The similarity in timing may reflect the similarity of the heard as opposed to written accent structure as well as the lead-in function of these bars. In the Cortot, the timing patterns of bars 16^2-17^1 and 24^4-25^3 are the same. Both precede either a climax (bar 16ff.) or the return of previous material (bar 24), the latter accentuated by a large pitch interval. In these cases, the local, direct relationships with the score are less obvious, and a combination of different factors may explain these repetitions of eighth-note beat timings.

Comparison among performances

The timing repetitions identified in the lattices were compared to the score and categorized according to the types described above (Table 1).

The number of repeated units identified was greatest for Szekely and smallest for Cortot. The extent of repetition identified in the Szekely is not surprising as the overall eighth-note length contour is relatively flat. Further-

Table 1. Number of repetitions identified in each performance and proportion within each type identified before. Here, repeated sections of four eighth-notes or more are presented.

	Type	*Cortot 1933*	*Ashkenazy 1967*	*Szekely 1987*
Total number of repeats		77	49	118
% of repeats coinciding with:				
Repetition in score	1	42	6	14
Similar structural positions	2	21	28	37
Total % of above		62	35	52
Fast section (bars 38-53)	3	23	49	
None of the above	4	14	16	48

more, for this performance, the proportion of repeated timing units occurring with score-based repetitions is approximately the same as those that do not. This suggests that the timing patterns in this performance are primarily driven by a steady tempo in each of the sections, in what is the most metronomic of the performances. Cortot's and Ashkenazy's performances have far fewer exact timing repeats. The majority of Cortot's repetitions that coincide with the types mentioned above occur with exact and inexact repeats. For Ashkenazy, however, the majority of repetitions occur in structural areas that are similar in terms of either phrase or metrical position.

DISCUSSION

This study of performances of Chopin's Etude, using a combination of a pattern-matching approach and Formal Concept Analysis, identified four types of repeated timing patterns. These coincide with a number of different characteristics of the notated music. The types seem to be related to a range of factors, including: (1) global characteristics of the performance such as the general tempo, (2) tempo within sections, (3) motivic material identifiable in the score, and (4) structural characteristics. Exact repetition does not always occur when repetition would be predicted from the notated music.

There are differences in the areas of timing repetitions: some have repetitions in most performances, others have repetitions in fewer performances, and yet others contain repetitions that are unique to one performance. It seems possible to characterize the timing features of the various performances in terms of patterns that play different roles in each interpretation. In Szekely's, the steady metronomic pulse dominates, and therefore, for the most part, any one repetition may not be salient. In Cortot's and Ashkenazy's performances, in which the timing patterns are more varied, repetitions are rarer and signal different aspects of the music, some coinciding with specific score-based repetitions and some with more general functional positions. Cortot's repetitions coincide with those of themes, motives, and metrical properties of the music as notated, while Ashkenazy's also occur in areas of similar structural status. Cortot's repetitions therefore seem thematically, motivically, or metrically driven, whereas Ashkenazy's seem "architecturally" driven. These repetition types may form the basis of "performance motives" lending coherence to performances and may contribute to our perception thereof by emphasizing connections in the piece.

Acknowledgments

This work was partly supported by the AHRC Research Centre for the History and Analysis of Recorded Music (CHARM).

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References

Con Exp Package, Concept Explorer: http://conexp.sourceforge.net.

Friberg A. and Battel G. U. (2002). Structural communication. In R. Parncutt and G. E. McPherson (eds.), *The Science and Psychology of Music Performance: Creative Strategies for Teaching and Learning* (pp. 199-218). Oxford: Oxford University Press.

Ganter B. and Wille R. (1999). *Formal Concept Analysis: Mathematical Foundations*. Berlin: Springer-Verlag.

Moore B. J. C. (1997). *An Introduction to the Psychology of Hearing*. London: Academic Press.

Repp B. H. (1998). A microcosm of musical expression. I. Quantitative analysis of pianists' timing in the initial measures of Chopin's Etude in E major. *Journal of the. Acoustic Society of America*, *104*, p. 1085-1100.

Réti R. (1961) *The Thematic Process in Music.* London: Faber and Faber.

Rink J. (2004) Analyzing rhythmic shape in Chopin's E major Etude. In A. Szklener (ed.), *Analytical Perspectives on the Music of Chopin* (pp. 125-138). Warsaw: NIFC.

Sonic Visualiser, http://www.sonicvisualiser.org, http://mazurka.org.uk/software/sv.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The role of timbre in expressive musical performance: A case study of Bach's *Prelude* BWV 998 played on the acoustic guitar

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This study explores the measurable properties of expressive timbre through recordings of Bach's *Prelude* BWV 998 played on the acoustic guitar. A number of "test" recordings were made, whereby each note throughout the passage was played with a different right hand fingering technique (varying the location of the plucking fingers along the length of the strings and the balance of flesh and nail in the attack). Using the fast Fourier transform, comparisons in spectral energy distribution were made between the different test recordings at the whole bar and individual note levels. Analysis of the test recordings showed a clear quantitative difference in spectral sound quality according to the right hand fingering technique employed. A number of "natural" performances were then recorded and analyzed in the same way and these data compared to the test recordings, in order to establish the right hand fingering technique used for each note played, and the results were illustrated graphically on a piano roll-type score. Thus, the objective study of expressive timbral variation can be achieved.

Keywords: music performance; expressive performance parameters; timbre; spectral analysis; acoustic guitar

This study concerns the measurement of expressive variations in timbre. Manipulation of timbre is one of the main ways by which a performer communicates ideas and emotions (Seashore 1938). Timbre is a fundamental and personal vehicle for conveying expressive intent, making a vital contribution to the communication of emotion in music, from performer to listener (Gabrielsson and Juslin 1996). Yet, of the audible manifestations of music performance, it is arguably still the least understood.

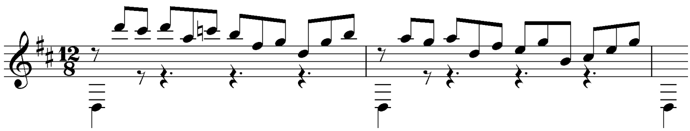

Figure 1. The opening bars of Bach's *Prelude*, BWV 998.

Performers use timbral variations to convey a multiplicity of musical messages, both structural and emotional. Choices as to what quality of tone will be produced at any given moment will be made according to the player's perception of context, their own imagination, and expressive and interpretative intentions. A means of measuring the nature and variation of the sounds produced would be a valuable step toward enabling greater understanding of the nature and potential of tone quality in musical performance.

A preliminary study into expressive timbral variation has been presented by the authors involving the analysis of individual notes played on the acoustic guitar (Earis and Holmes 2003). By studying the spectral qualities of the sound produced, individual differences in timbre were quantified. In this paper, the earlier method is extended to the analysis of a 10 bar passage of a guitar performance (121 notes) of Bach's *Prelude* BWV 998.

METHOD

The guitar was chosen for a number of reasons. Since the fingers of both hands are in contact with the strings, the player has direct control over the sound. The performer has a number of distinct technical devices at his disposal to change the quality of the sound produced. The subject was an experienced solo performer and professor at the Royal College of Music.

The study was in two parts. Initially, a number of "test" recordings were made, whereby each note throughout the passage was played with a different right hand fingering technique. Spectral analysis techniques were used to parameterize and measure the acoustic differences between the recordings. Secondly, a number of "natural" performances were recorded and analysed in the same way. These data were then compared with the test data in order to establish the right hand fingering techniques used for each note played.

There are a number of technical terms associated with changes of right hand position and articulation in guitar playing:

- The location of the right hand along the length of the strings
  - *sul ponticello* (toward the bridge, giving clarity and brightness)
  - *sul tasto* (over the fingerboard, giving a warmer sound)
  - *natural position* (over the sound hole)
- The part of the finger making contact with the string during the attack
  - *flesh* (softer sound)
  - *nail* (more perpendicular strike and harder sound)

In practice, players will normally use a combination of nail and flesh. These three dimensions of tone production can be chosen independently of each other and can each be infinitely varied on a continuous spectrum.

EXPERIMENT 1

A number of "test" recordings, using different right hand fingering techniques were made and these are described in Table 1.

The microphone was placed 50 cm from the sound source in an unreverberant acoustic. Each recording was made at 44.1 kHz with 16 bits.

Experiment 1 measured the global differences between the "test" recordings. Using the fast Fourier transform (FFT) with rectangularly-windowed whole bar segments of each recording, the frequency of the median and quartile spectral energy was measured. Figure 2 illustrates the percentage difference in median frequency for different right hand fingering techniques when compared with the "normal" performance (recording 1). When comparing different right hand positions, the median frequency for *sul tasto* is lower (mean 8.4%) and that for *sul ponticello* higher (mean=37.7%). This indicates that the lower harmonics are stronger when playing *sul tasto* and vice versa for *sul ponticello*. When changing from predominantly flesh to predominantly nail, the median frequency increases (mean=11.7%) and increases still further when additionally playing *sul ponticello* (mean=78.6%).

Table 1. The "test" recordings.

Recording	*Right hand position*	*Description*	*Flesh/nail*
1 (normal)	Natural	Over the sound hole	Flesh
2	Sul ponticello	Nearer the bridge	Flesh
3	Sul tasto	Nearer the fingerboard	Flesh
4	Natural	Over the sound hole	Nail
5	Sul ponticello	Nearer the bridge	Nail

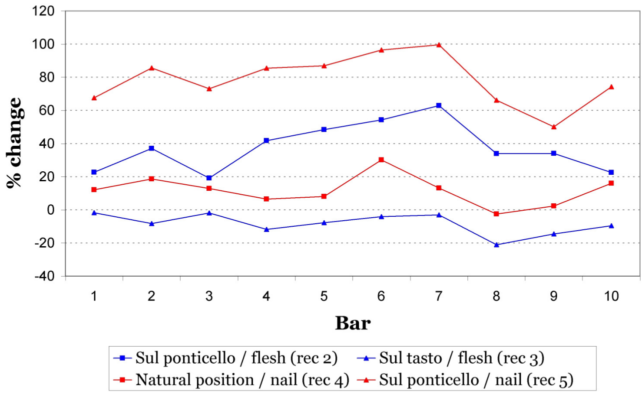

Figure 2. A graph illustrating the percentage change in the frequency of the median spectral energy for each bar when changing from the natural position with predominantly flesh (recording 1) to *sul ponticello* (recording 2) and *sul tasto* (recording 3), and when changing from predominantly flesh to predominantly nail (recording 4) and predominantly nail and *sul ponticello* (recording 5). (See full color version at www.performancescience.org.)

EXPERIMENT 2

Experiment 2 explored the differences between the "test" recordings at the individual note level. From the results of Experiment 1, it appears that there are changes in the relative energy of the lower harmonics, suggesting changes in the fundamental frequency (f_0) energy. The normalised energy of the lowest harmonic of each note in each recording was measured by windowing the signal using a Hamming window of length 150 ms, starting at each note onset time and using an FFT of order 32768, with zero padding. The normalised f_0 energy for each note can be illustrated by a piano-roll type score using a color scaling to indicate energy. For each recording, differences at the individual note level were similar to those seen in Experiment 1. As well as analysis of the test recordings described in Table 1, an additional recording, where the performer alternates between flesh and nail throughout the performance, was made, and this is shown in Figure 3, alongside the piano roll-type score for the "normal" recording. The change in each bar between the two different types of attack can be seen by the change in color in the piano roll-type score, as well as in the bar chart of differences between corresponding notes.

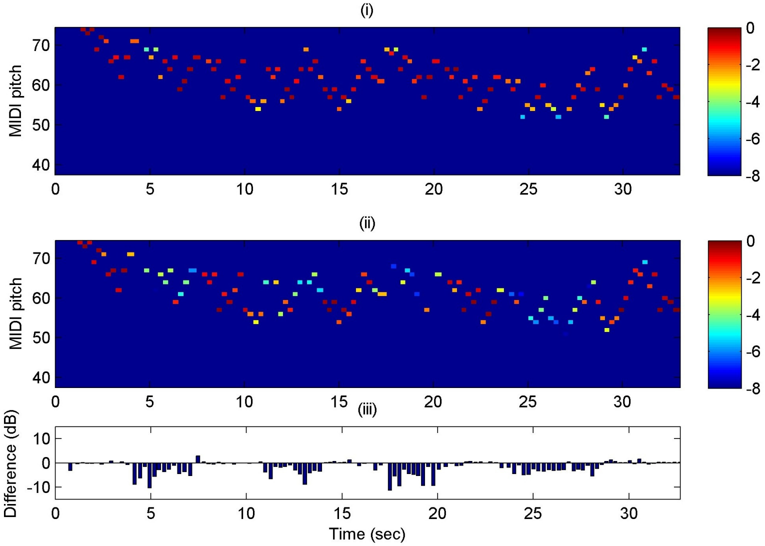

Figure 3. Piano roll-type score for two different recordings. Time is illustrated on the horizontal axis and MIDI pitch on the vertical axis. The color scaling is in decibels. (i) The normalized f_0 energy for the "normal" performance. (ii) The performer alternating between predominantly flesh and predominantly nail. (iii) A bar chart of the differences. (See full color version at www.performancescience.org.)

DISCUSSION

It has been shown how acoustic differences between different right hand techniques were measured at both the bar and individual note level. This data was then used to study a number of "natural" performances, with the guitarist using the expressive devices at his disposal to give his individual interpretation of the passage. Each note was analyzed using the method described in Experiment 2, and these measurements were then compared to those for the equivalent note in each test recording and the closest match found. This match is used to indicate the most likely right hand fingering technique for that note, and this is illustrated in piano roll-score in Figure 4 for one of the performances. The recording begins in the natural position using predominantly flesh in the attack. It evolves toward a more *sul tasto* position, with some color in the middle achieved using nail and *sul ponticello*.

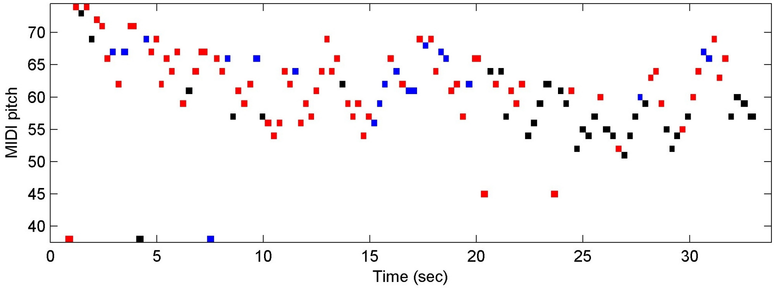

Figure 4. Piano roll-type graphs for a "natural" performance. Red=natural position and predominantly flesh, black=*sul tasto*, blue=*sul ponticello* and nail. (See full color version at www.performancescience.org.)

This type of analysis allows the objective study of expressive timbre. Such measurements can enable an accurate analysis of the tonal elements of performance in a range of contexts, particularly if the range and scope of the measured parameters is increased in future work. The techniques used in the current study have the potential to give real time visual feedback to instrumentalists. This could be a valuable resource for both players and teachers, not least in creating a novel resource for practice. It is hoped that by facilitating understanding of the nature and effects of timbre, this study will enable performers of all levels to realize its potential as a powerful channel for the direct communication of emotional and intellectual interpretative ideas. For further results and sound recordings, see www.cph.rcm.ac.uk/acoustics.

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References

Earis A. and Holmes P. A. (2003). Quantitative analysis of tone quality: A study in the acoustic properties of individual guitar sounds. In R. Kopiez, A. C. Lehmann, I. Wolther, and C. Wolf (eds.), *Proceedings of the 5th Triennial ESCOM Conference* (p. 84). Hanover, Germany: Hanover University of Music and Drama.

Gabrielsson A. and Juslin P. (1996). Emotional expression in music performance: Between the performer's intention and the listener's experience. *Psychology of Music*, *24*, pp. 68-91.

Seashore C. E. (1938). *Psychology of Music*. New York: McGraw-Hill.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Tendencies of piano interpretation in the twentieth century: Concept and different types of "piano interpretation schools"

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The aim of this paper is to consider whether the concept of a "piano interpretation school" is a useful concept from which to analyze the quality and development of Western classical piano performance. It is possible to trace lines that seem to share certain common characteristics—namely, aesthetics, technique, history, and the commonly learned and performed repertoire. Throughout my career as a pianist, I have noticed the coexistence of different tendencies in the tradition of piano performance, the most common being the "Russian School" and "German School." Each seems to define a certain approach to general playing and/or specific repertoire, involving characteristic sonority, favored repertoire, specific tempi, use of pedal, different piano makers, pedagogical methods, and technical interpretive approaches (use of rubato, polyphonic clarity, etc.). The concept of the "piano interpretation school" needs to be questioned and discussed, not only for analysis and systematization, but also for the subjectivity it allows. The privileged relationship of the teacher and student, through the transmission of certain performing approaches and repertoire selections, as well as through the transmission of technical resources, can support the definition of a certain school of piano interpretation. This paper ends by discussing this teacher-student legacy.

Keywords: typification; national piano schools; German; Russian; French

During my research between 2001 and 2004, I analyzed available recordings of 19 mainstream piano works by 29 pianists who started their piano careers prior to 1950. The pianists included C. Arrau (1903-1991), Backhaus (1884-1969), Busoni (1866-1924), Casadesus (1899-1972), Ciccolini (1925), Cortot (1877-1962), Jeanne-Marie Darré (1905-1999), Feinberg (1890-1962), Fischer

(1886-1960), Samson François (1924-1970), Gieseking (1895-1956), Gilels (1916-1985), Ingrid Haebler (1929), Clara Haskil (1895-1960), Josef Hofmann (1876-1957), Horowitz (1904-1989), Kempff (1895-1991), Alicia de Larrocha (1923), Vitaly Margulis (1926), Arturo Benedetti Michelangeli (1920-1995), Paderewsky (1860-1941), Perlemuter (1904-2002), Egon Petri (1881-1962), Rachmaninov (1924-1970), Richter (1915-1998), Artur Rubinstein (1889-1982), A. Schnabel (1882-1951), Alexander Scriabin (1892-1915), Vladimir Sofronitzky (1901-1961). These pianists formed part of a check-list survey used in an attempt to develop a typification of national interpretation piano schools.

The concept of the "piano interpretation school" can be useful. I highly recommend among the relevant literature the following authors: Carl Phillip Emanuel Bach (1949), Alfredo Casella (1936), Luca Chiantore (2001), Edwin Fischer (1956), A. Kullak (1876), V. Margulis (2001), H. Neuhaus (1967), P. Rattalino (1982, 1992), Ch. Timbrell (1992), and J. Zlatar (1997). These authors expand different approaches to general playing and/or specific repertoire, involving characteristic sonority, favored repertoire, specific tempi, use of pedal, different piano makers, pedagogical methods, and technical interpretive approaches. Some of the very important information all musicians gained during their one-to-one lessons since childhood came from the oral tradition of instrumental education. In the above listed literature, I found much of the information written down that I had received from my piano teacher during my weekly piano lessons. That is why they are so important and fascinating for this subject: they show the written word to the users of the spoken word.

The aim of this paper is to consider whether the concept of a "piano interpretation school" is a useful concept from which to analyze the quality and development of Western classical piano performance. It is possible to trace lines that seem to share certain common characteristics—namely, aesthetics, technique, history, and the commonly learned and performed repertoire.

METHOD

Participants

To support my personal observations, a check-list survey was used in order to develop a typification of national interpretation piano schools. This was done by listening to three different recordings of important pianists who developed their performance careers during first part of twentieth century: Vladimir

Sofronitzky (1901-1961), Edwin Fischer (1886-1960), and Robert Casadesus (1899-1972).

Materials

For this research, three recordings of the first movement of Beethoven's Sonata op. 57, *Appassionata* (specifically bars 1-50, which included the exposition—first and second themes) by Vladimir Sofronitzky, Edwin Fischer, and Robert Casadesus were used.

Procedure

Analysis involved observation and comparison of the three short samples, in particular addressing expressive elements like dynamics (crescendi/ diminuendi), specific tempi, phrasings, articulation, use of pedal, different makes of pianos, pedagogical methods, and technical and interpretive approaches (use of *rubato*, polyphonic clarity, agogic patterning, etc.).

Three recordings by three different pianists considered to be possible representatives of national piano schools—German, Russian, and French—playing the first movement of Beethoven's Sonata *op. 57, Apassionata,* were used in this present research. This work was chosen because is it a very representative work within the piano repertoire and is easy to obtain because it has been frequently recorded. The main purpose was to analyze by comparison how a pianist of the German piano school differs from one of the Russian or French schools. It is very important to stress the fundamental role of the individual's unique artistic personality when we are listening to a piano recital and not to necessarily associate it with a national "piano interpretation school."

RESULTS

The following recordings are to be used in the presentation as a short demonstration of the extensive check-list survey: Sofronitzky (1901-1961; *V. Sofronitzky vol. 7,* Arlechino, 1939), E. Fischer (1886-1960; *Edwin Fischer Plays Beethoven, Pathétique, Appassionata, Emperor,* Pearl, GEMM CD 9218, 1996, recorded in London, 1935), and Robert Casadesus (1899-1972; *Beethoven Piano Sonatas*, Sony Classical, SBK 46345, 1990). A summary of the results is presented in Table 1.

Comparing the check-list survey concerning dynamics, tempo, phrasing, use of pedal, and textures (as demonstrated in Table 1), we come to certain

Table 1. Beethoven, Sonata op. 57, *Appassionata*, first movement.

	Dynamics	*Tempo*	*Textures*
V. Sofronitzky (Russian School)	Unbalanced dynamics	Slower tempo, vocal character, agogic patterning, sudden allargandi, often changing tempo	Polyphonic sonority with weight making structure clearer, showing voice leading
Edwin Fischer (German School)	Balanced dynamics	Stable tempo	Clear phrasing
Robert Casadesus (French School)	Balanced dynamics	Faster tempo than Sofronitzky, instrumental character less vocal	Less voice leading or polyphonic sonority: importance of clear *jeu perlé* and *souple* piano playing

conclusions concerning this part of this Beethoven sonata. Those conclusions can be extended to more general ideas concerning the different "piano interpretation schools."

The Russian school is particularly concerned with character and expression while the German school is more concerned with structure. Comparing the musical textures in the interpretation of this example, we come to the conclusion that "weight technique" is very important for the achievement of a certain musical effect. Sofronitzky shows this effect clearly by his use of polyphonic sonority with "weight," resulting in a clearer structure and more defined voice leading. Edwin Fischer prefers balanced dynamics and stable tempo, whereas Casadesus chooses to stress the instrumental character and show the importance of clear *jeu perlé* and *souple* piano playing.

Along with Franz Liszt (1811-18186), the important piano teacher Theodor Leschetizky (1830-1915) taught how everything had to sing and to have a colored sound even when it was quiet. As the French pianist Paul Loyonnet (1889-1988) suggests:

> The use of weight and arm was not much cultivated in France, that is true. Today of course, the picture has changed. But the Russians and the Germans have always used more, and the reason is that their music demands it. It is a fact that composers engender the education of interpreters. For the French, there can be grandeur without heaviness and passion without violence. The dreamlike aura of Fauré is rarely

> appreciated in full outside France, and even there it is not meant to act directly on a crowd, like Tchaikowsky can (cited in Timbrell 1999, p. 191).

The French school is very similar to the German School with regards to “the unconditional respect for the text,” as Marguerite Long suggested (Timbrell 1992). The *jeu perlé* and *claret* of French playing, however, does not usually need the sonority of arm weight technique that the Russian and German schools employ.

DISCUSSION

This work raises a number of questions that beg further investigation, such as whether or not “piano interpretation schools” do still exist after 1950. As well, it would be important to consider whether or not some pianists could be representative of two different “piano interpretation schools.” Lastly, and perhaps most importantly, is the need to explore the balance and relationship between a pianist’s genius and individual artistic ability and their respective “piano interpretation school.” Is one more important that the other for the art of piano performance? Or rather, *should* one be of greater importance than the other? These questions, among others, require further enquiry to better understand the relevance of national “piano interpretation schools” for today’s performing pianists.

Acknowledgments

To Professor Dr. Rui Vieira Nery (University of Évora-Portugal) and Professor Dr. Ulrich Mahlert (Universität der Künste Berlin-Germany) for coaching and supervising my research on “National Piano Interpretation Schools,” which finished with the accomplishment of my Doctoral Thesis at University of Évora in 2005.

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References

Bach C. P. E. (1949). *Essay on the True Art of Playing Keyboard Instruments*, (translated by W. J. Mitchell). New York: W. W. Norton.

Casella A. (1993). *El Piano*, (11th ed., translated by Carlos Florianni). Milan, Italy: G. Ricordi.

Chiantore L. (2001). *Historia de la técnica pianística: Un estudio sobre los grandes compositores y el arte de la interpretación en busca de la Ur-Technik*. Madrid: Alianza editorial.

Fischer E. (1956). *Ludwig van Beethoven's Klaviersonaten: Ein Begleiter für Studierenden und Liebhaber*. Wiesbaden: Im Insel Verlag.

Kullak A. (1876/1994). *Die Aesthetik des Klavierspiels*. Regensburg: ConBrio Verlagsgesellschaft.

Leimer K. and Gieseking W. (1998). *Modernes Klavierspiel* (28th ed). Mainz, Germany: Schott.

Margulis V. (2001). *Bagatelas op. 6*, Vila Nova de Famalicão, Quasi Edições.

Neuhaus H. (1981). *Die Kunst des Klavierspiels* (5th ed.). Köln, Germany: Edition Gerig.

Pfeiffers T. (1993). *Studien bei Hans von Bülow, Nachtrag von José Vianna da Motta*, (English version by R. L. Zimdars, *The Piano Master Classes of Hans von Bülow-Two Participants' Accounts*). Indianapolis, Indiana, USA: Indiana University Press.

Rattalino P. (2001). *Le Grandi Scuole Pianistiche* (2nd ed.). Milan, Italy: Casa Ricordi—BMG Ricordi S.p.A.

Rattalino P. (1997) *Storia del Pianoforte. Lo Strumento, La Musica, Gli Interpreti* (2nd ed.). Milan, Italy: Il Saggiatore.

Riemann H. (2005). *Manual del Pianista*. Huelva, Spain: Idea Musica.

Timbrell C. (1999). *French Pianism: A Historical Perspective* (2nd ed.). Portland, Oregon, USA: Amadeus Press.

Vianna Da Motta J. (1941). *Música e Músicos Alemães: Recordações, Ensaios e Críticas*. Coimbra, Portugal: Publicações do Instituto Alemão da Universidade de Coimbra.

Zlatar J. (1997). *An Introduction to Piano Interpretation*. Zagreb, Croatia: Music Academy of Zagreb.

Thematic session:
Science of the Voice

International Symposium on Performance Science
ISBN 978-90-9022484-8

Voice source and acoustic measures of girls singing "classical" and "contemporary commercial" styles

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The understanding of the singing voice of children and adolescents is still in its infancy, and there is a lack of a general developmental model of the young voice, in particular with relation to young singers. Available research has largely also been on "classically" trained voices, and contemporary commercial music (CCM) including pop/rock and musical theatre has largely been ignored. This study examined laryngographic and acoustic analysis of 10 young female singers, aged 14-17, training using a system which includes both classical and CCM techniques, particularly musical theatre (MT). Singers were found to have generally higher vocal fold closed quotient (CQ) at most pitches when singing in an MT style than in a classical style. The spectral slope was also found to be generally shallower for MT singing than classical, particularly over F0-F5.

Keywords: singer; musical theatre; acoustic; closed quotient; adolescent

The use of quantifiable voice measurements has been introduced in a number of singing studios with adult voices to provide biofeedback on the voice during coaching (Howard *et al.* 2003) and can provide both a pedagogic tool and a monitor of vocal health. Biofeedback tools based on Laryngographic analysis of F0 have been previously used with success in teaching children to pitch accurately (Welch *et al.* 1989). Analysis of vocal fold closed quotient (CQ), spectrographic analysis, and vocal tract modeling (Howard *et al.* 2003) have also been used to assess vocal production in adult singers and provide computer-based feedback.

A number of studies have examined quantifiable aspects of young singers' voices from a variety of perspectives, using laryngography (e.g. Pedersen 1997, Barlow and Howard 2002) and voice range profile (VRP; e.g. McAllister *et al.* 2000). However, despite this, quantifiable voice analysis of young singers to inform use of biofeedback tools is still limited in scope and quantity. There is a particular lack of research on voice production in contemporary commercial music (CCM; including musical theatre), despite the fact that young people are still the most likely demographic group to undertake training in singing (Barlow 2003), and particularly CCM. The theatre arts organization Stagecoach alone has over 39,000 students training in acting, dancing, and singing (Cole 2007).

The Brooklyn Youth Chorus Academy© is a uniquely positioned organization, working with a large number of international names from both the CCM and classical music worlds. The chorus regularly performs alongside artists as disparate as Elton John and the New York Philharmonic Orchestra. As such, the singers need to be able to adapt their vocal style according to the musical genre being performed.

Cross-Choral Training® (C-CT) is BYCA's program for developing vocal and musicianship skills in a choral setting. C-CT enables the singers to perform intentionally in a variety of coordinated adjustments and vowel sound qualities so the chorus can easily respond to the musical and expressive demands of diverse repertoire, including both CCM and classical styles of performance, and can sing any style of music appropriately.

This pilot study examines measurable parameters of ten BYCA students and aims to ascertain if quantifiable differences occur in voice production by the same student singing in both classical and musical theatre styles.

METHOD

Participants

Ten female students from the Brooklyn Youth Chorus Academy© took part in the study. Students were aged 14-17 years and were all designated as "trained" singers under the criteria used by the authors in previous studies (Barlow and Howard 2005, 2006). All students had a minimum of three years training under the C-CT system. All students spoke American English.

Materials

Subjects were recorded speaking and singing using a headset mounted electret reference microphone to record the speech signal (Sp) and a

Laryngograph®, which was used to record the laryngographic signal (Lx). The Lx signal was viewed on an oscilloscope during the recording to maintain correct electrode positioning. Recordings were made using the Laryngograph Microprocessor directly onto a Toshiba Libretto micro-laptop with 1Gb RAM and a Pentium Mobile processor running at 1.2 GHz. Sampling rate was 24 kHz, with 16 bit resolution.

Procedure

Subjects were recorded using a standard protocol: (a) reading aloud a passage of spoken text approximately 90 s in duration to determine mean spoken F0; (b) singing a verse of "happy birthday" in a classical style (termed "head" in C-CT terminology) in the key of C Major and then repeating it in a musical theatre style (termed "mix" in C-CT terminology). Five notes from the song were extracted for detailed laryngographic and acoustic analysis, including mean F0, long term average spectra, and mean CQ for each note.

The notes studied were taken from words on the root, third, fifth, seventh, and octave of the scale. Two notes were on the vowel "æ" (e.g. happy), one on the vowel "ɝ" (e.g. birth), and two on the vowel "u" (e.g. to, you). The musical phrase is shown in Figure 1.

SpectraLab© was used to generate Long term average spectra (LTAS) using a Hanning window with an FFT size of 2048 samples. This was used to derive the intensity of harmonics up to F5 (referenced to F0) for each note. Laryngographic data was used to calculate mean CQ values for each note.

RESULTS

LTAS analysis was used to calculate the mean intensity of each harmonic relative to F0 for each note. A higher mean intensity for the mix (CCM) voice was demonstrated in all harmonics up to F5 for all notes, particularly in harmonics F3-F5. For many notes sung in mix, the harmonics F1-F3 are stronger than the fundamental, and the overall spectral slope is relatively shallow over the first 5 harmonics. The classical (head) voice shows much weaker harmonics particularly above F2, and a much steeper spectral slope.

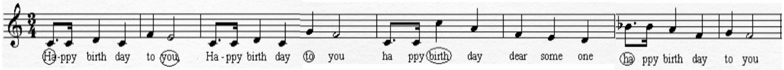

Figure 1. Happy birthday—syllables selected for analysis circled.

Table 1. Mean intensity of harmonic series.

				Mean intensity (dB)				
Voice	*Note/vowel*	*Freq (Hz)*	*F0*	*F1*	*F2*	*F3*	*F4*	*F5*
Head	C4/æ	262	0	-3.10	-0.45	-2.49	-7.08	-17.95
Mix	C4/æ	262	0	-1.05	5.66	7.62	-3.76	8.84
Head	C5/ɝ	523	0	-2.10	-7.99	-19.55	-22.91	-27.86
Mix	C5/ɝ	523	0	-1.38	-6.77	-12.90	-11.13	-17.97
Head	Bb4/æ	466	0	3.70	-0.55	-10.81	-23.98	-29.65
Mix	Bb4/æ	466	0	6.91	0.35	-2.37	-16.57	-12.08
Head	G4/u	392	0	-12.71	-21.21	-24.14	-29.86	-30.03
Mix	G4/u	392	0	-11.03	-22.88	-13.50	-19.59	-18.44
Head	E4/u	329	0	-16.05	-20.33	-21.70	-26.91	-43.72
Mix	E4/u	330	0	-11.58	-24.61	-23.42	-11.09	-12.84

Table 2. Mean larynx closed quotient (and standard deviation) for each note.

Voice		C4/æ	E4/u	G4/u	Bb4/æ	C5/ɝ
Head	Mean CQ% (SD)	26.2 (6.2)	25.6 (6.2)	24.6 (5.9)	28.3 (4.8)	28.2 (5.9)
Mix	Mean CQ% (SD)	31.1 (2.9)	31.1 (5.4)	29.4 (4.4)	33.6 (3.6)	27.8 (4.8)

Mean CQ was calculated for each note across the group for both singing styles (Table 2). Figure 2 shows mean CQ and standard deviation for 4 of the 5 notes analyzed is higher in 'mix', with the mean for C5 being nearly identical. Analyzed as individuals across all notes, 76% of mean CQs were higher in 'mix' voice than in 'head'. A one tailed student's T-test of the means demonstrated a significant difference between the two data sets (p=0.018).

DISCUSSION

The results clearly show consistent differentiation in both vocal function and acoustic output between the two different singing styles. The long term average spectra show a distinct increase in intensity of harmonics up to F5 for the CCM voice compared to the classical style of singing. This indicates potential differences in both voice source and resonance strategies for the performer between the two different singing styles.

Scherer (2005) demonstrated that pressed phonation increases the strength of harmonics and decreases the spectral slope of the glottal

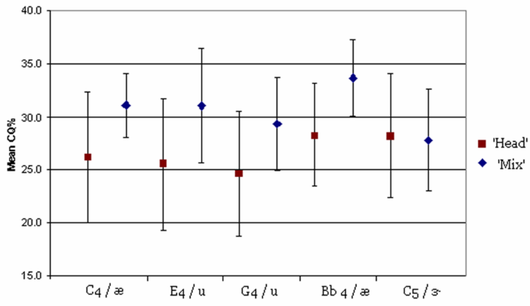

Figure 2. Mean CQ and standard deviation for each note/vowel sound.

waveform. Adult "belt" voices have been previously demonstrated to use significantly more pressed phonation than classical "bel canto" voices (Evans and Howard 1993), as demonstrated by raised CQ values.

The CQ data appears to support this finding, demonstrating raised CQ for mix singing compared with classical, suggesting stronger harmonics in the glottal waveform. The difference in CQ is relatively small, though significant between the two styles.

Scherer (2005) indicates that the glottal waveform of pressed phonation will have a negative slope, so these results suggest use of vocal tract resonances in CCM singing to further enhance harmonics up to F5, giving the characteristically "bright" sound to the voice of the young MT singer compared to the "rounded" tone of a classically trained singer.

Previous studies by the authors on classically trained choristers in the UK (Barlow and Howard 2005) demonstrated links between CQ and pitch. The pattern of mean CQ against pitch is almost exactly replicated here, suggesting that the classical singing style used by the BYCA is the same as that used by other conventionally classical youth choirs. Although vocal development over adolescence has been indicated to decrease sung CQ among classically trained girls (Barlow and Howard 2006), there is no apparent link shown by this data set between mean sung CQ and mean spoken F0.

Acknowledgments

The authors would like to acknowledge the support of the participants and also Dianne Berkun and Gail Stone of the BYCA, without whom this research could not take place. This research project is supported by the Arts and Humanities Research Council, grant number AH/E000721X/1. Cross-Choral Training© is a registered trademark of the Brooklyn Youth Chorus Academy, Brooklyn, New York, USA.

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References

Barlow C. A. (2003). *Electrolaryngographically Derived Voice Source Changes of Child and Adolescent Subjects Undergoing Singing Training* Unpublished doctoral thesis, University of York.

Barlow C. and Howard D. M. (2002). Voice source changes in child and adolescent subjects undergoing singing training. *Logopedics Phoniatrics Vocology, 27*, 66-73.

Barlow C. and Howard D. M. (2005) Évaluation Électrolaryngographique des effects des cours de chant et du sexe sur la source vocale des chanteurs and chanteuses prépubères. *Medecine des Arts*, *52*, pp. 12-19.

Barlow C. and Howard D. M. (2006) Measured characteristics of development in adolescent singers. *Proceedings of the 4th Sound and Music Computing Conference SMC07*. (pp 101-107) Athens, Greece: University of Athens

Cole G. (2007) *Stagecoach Theatre Arts Plc: Annual Report and Accounts*. London: Stagecoach Plc.

Evans M. and Howard D. M. (1993). Larynx closed quotient in female belt and opera qualities: A case study. *Voice, 2*, pp. 7-14.

Howard D. M. (1995). Variation of electrolaryngographically derived closed quotient for trained and untrained adult female singers. *Journal of Voice*, *9*, pp. 163-172.

Howard D. M., Welch G. F., Brereton J., and Himonides E. (2003). Towards a novel real-time visual display for singing training. *Proceedings of the 3rd International Workshop on Models and Analysis of Vocal Emissions for Biomedical Applications MAVEBA-3* (pp. 179-182). Florence, Italy: University of Florence.

McAllister A., Sederholm E., and Sundberg J. (2000). Perceptual and acoustic analysis of vocal registers in 10 year old children. *Logopedics Phoniatrics Vocology, 25*, pp. 63-71.

Scherer R. C. (2005). Laryngeal function during phonation. In R. T. Sataloff (ed.), *Voice Science* (pp. 167-184). San Diego, California, USA: Plural Press.

Welch G. F., Howard D. M., and Rush C. (1989) Real-time visual feedback in the development of vocal pitch accuracy in singing. *Psychology of Music*, *17*, pp. 146-157.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Choral singing and psychological wellbeing: Findings from English choirs in a cross-national survey using the WHOQOL-BREF

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Over 600 choral singers drawn from English choirs completed the WHOQOL-BREF questionnaire to measure physical, psychological, social, and environmental wellbeing, and a 12-item "effects of choral singing scale." They also provided accounts of the effects of choral singing on quality of life, wellbeing, and physical health in response to open questions. High average scores were found on all WHOQOL-BREF scales, and a high degree of consensus emerged on the positive benefits of choral singing, but substantial variations were also found. Within a group of participants with relatively low psychological wellbeing and strong perceptions of positive benefits associated with choral singing, four categories of significant personal and health challenges were found: enduring mental health problems; significant family/relationship problems; significant physical health challenges; and recent bereavement. Their accounts also revealed six "generative mechanisms" by which singing may impact on wellbeing and health: positive affect; focused attention; deep breathing; social support; cognitive stimulation; and regular commitment.

Keywords: choral singing; psychological wellbeing; English choirs; survey; WHOQOL-BREF

A number of qualitative and survey studies with diverse samples have shown that singers report a wide range of social, psychological, spiritual, and health benefits associated with singing (e.g. Clift and Hancox 2001, Bailey and

Davidson 2005, Silber 2005, Beck *et al.* 2000). Clift and Hancox (2001), for example, report that 71% of singers in a university choral society agreed that singing was beneficial for their "mental wellbeing." On a more objective level, research has demonstrated the impact of singing on physiological variables assumed to have wellbeing and health implications (e.g. Beck *et al.* 2000, Kreutz *et al.* 2004). In addition, Houston *et al.* (1998) report significant improvements in assessed levels of anxiety and depression in nursing home residents using common standardized measures, following a four-week program of singing, and Cohen *et al.* (2006) found significant improvements in both mental and physical health in elderly people participating over one year in a community choir. Shortcomings in the current literature, however, are the lack of a common conceptual understanding of wellbeing and health, and the absence of a theoretical framework that elucidates the generative causal mechanisms linking singing with wellbeing and health benefits (Harré 1972). The present study aims to address these shortcomings through a large-scale survey with choral singers in England, Germany, and Australia based on the World Health Organization Quality of Life project (Power *et al.* 1999). The present paper reports some preliminary findings from the English arm of the study.

METHOD

Participants

The sample consisted of 633 choral singers drawn from choral societies and choirs in the South East and North East of England. Response rates by choir ranged from 50-70%. The mean age of choristers was 61 years; 77% women and 23% men.

Materials

The questionnaire employed included three open questions on the effects of singing on quality of life, wellbeing, and health, followed by 24 statements about possible effects of choral singing based on instruments used in studies reported by Clift and Hancox (2001) and Beck *et al.* (2000).

Participants also completed the WHOQOL-BREF (the short form of the World Health Organization Quality of Life Questionnaire) which measures four dimensions of life quality: physical (e.g. How much do you need medical treatment to function in your daily life?), psychological (e.g. How much do you enjoy life?), social (e.g. How satisfied are you with the support you get from your friends?), and environmental (e.g. How satisfied are you with the conditions of your living place?), with high levels of reliability and validity (e.g. Skevington *et al.* 2004, Hawthorne *et al.* 2006)

Procedure

Questionnaires were distributed to members of participating choirs during May 2007 for completion at home and return in a sealed envelope.

RESULTS

Principal Components Analysis of the choral singing items identified a strong first component with substantial loadings from 12 items (e.g. improved mood, enhanced quality of life, greater happiness, stress reduction, and emotional wellbeing). These items were used to construct a single measure of the perceived effects of singing on wellbeing (Cronbach alpha $\alpha=0.9$, for both sexes). A high mean score confirmed that a large majority of choristers agreed that singing has a positive impact on personal wellbeing. Individual differences were apparent, however, with women showing higher scores: men mean=48.0, SD=6.9; women mean=50.2, SD=6.7; $t=-3.39$, $p<0.001$ (2-tailed).

On the WHO psychological scale, a majority of respondents scored well above the scale midpoint indicating good/excellent psychological wellbeing. Approximately 10% of choristers, however, gave low scores, which could indicate mental health difficulties. Women scored slightly lower on this scale: men mean=23.6, SD=2.7; women mean=23.0, SD=2.9; $t=2.13$, $p<0.05$ (two-tailed).

A significant correlation between the two measures emerged for women ($r=0.27$, $p<0.01$), but not for men. The correlation for women, however, was very low, and the effective lack of relationship in both sexes suggests that some choristers with relatively low general psychological wellbeing nevertheless experience high levels of benefit from singing. Respondents in the lowest third on the psychological wellbeing scale, and the highest third on the effects of singing scale were considered of particular interest for understanding the impact of singing on wellbeing. In answers to open questions given by this group, approximately one quarter disclosed significant challenges in their lives:

- People with an enduring mental health problem:

> I have had to stop working due to an on-going medical condition [bi-polar disorder]. I have had several episodes of this requiring varying

> lengths of time spent in hospital, followed by months of time needing support for depression and lack of self-confidence. Being a member of this particular choir has lifted my self-esteem again and restored self-belief (woman, 54 years).

- People affected by significant family/relationship problems:

> As a carer of two relatives stricken with schizophrenia, have suffered from reactive depression.... Having a pleasant start to the day knowing I shall meet like-minded people and enjoy music making, hopefully having a laugh along the way. Hearing the harmonies helps me forget family worries (woman, 70 years).

- People affected by significant physical health issues/disability:

> It plays a significant part in my emotional health and wellbeing. I find music uplifting. When recovering from a major stroke, singing was one of the ways of lifting my spirits out of depression (man, 65 years).

- People who have been recently bereaved:

> My husband died three months ago so all the questions about negative feelings etc. are distorted by this fact. One of the greatest supports in my life at this difficult time is the Silver Singers and the other silver activities—ukulele, guitar, ocarina/tin whistle. I think choral singing is fantastic for emotional health (woman, 64 years).

Accounts given by this group also suggested at least six generative mechanisms linking choral singing with wellbeing and health:

- Choral singing engenders happiness and raised spirits, which counteract feelings of sadness and depression:

> When you sing, you cannot be sad for long. It really lifts your spirits. Being in a choir means you are in a team – you all help each other which gives tremendous satisfaction (woman, 52 years).

- Singing involves focused concentration, which blocks preoccupation with sources of worry:

> Singing in a choir puts troubles "on hold", as concentrating on the music requires all one's attention (woman, 65 years).

- Singing involves deep controlled breathing, which counteracts anxiety:

> Deep breathing, essential for singing, is one method of helping with signs of anxiety and stress (woman, 70 years).

- Choral singing offers social support and friendship, which ameliorate feelings of isolation and loneliness:

> The effect of singing with a group helps to make friends, so this has widened my horizons quite a bit, and gets me out and about more. The support you receive from other people helps in general wellbeing (woman, 78 years).

- Choral singing involves education and learning, which keeps the mind active and counteracts decline of cognitive functions:

> Apart from the relaxation benefits, I believe that for me, aged 57, keeping the brain active and having to concentrate for long periods will delay if not completely prevent senile dementia! (woman, 57 years).

- Choral singing involves a regular commitment to attend rehearsal, which motivates people to avoid being physically inactive:

> Making the effort to attend choir practice on wet, cold evenings instead of watching TV must be better for health (woman, 69 years).

DISCUSSION

This study addresses shortcomings of previous studies by undertaking a large-scale survey of singers using a rigorously developed cross-national instrument for assessing health related quality of life. The results confirm previous findings that a large majority of choristers perceive singing as beneficial for wellbeing. When choristers' perceptions of the effects of singing were examined in relation to the psychological scale of the WHOQOL-BREF, a high degree of independence indicated that some choristers with relatively low psychological wellbeing nevertheless strongly endorsed the benefits of choral singing. Accounts from such participants revealed that participation in singing has been of considerable help in coping with serious challenges to their general sense of wellbeing. More importantly, choristers provided valuable insights into various "generative casual mechanisms" (Harré 1972) through which singing serves to promote wellbeing by counteracting processes potentially detrimental to health.

Acknowledgments

Grateful thanks are given to the choristers who participated in this survey.

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References

Bailey B. A. and Davidson J. W. (2005). Effects of group singing and performance for marginalized and middle-class singers. *Psychology of Music, 33,* pp. 269-303.

Beck R. J., Cesario T. C., Yousefi A., and Enamoto H. (2000). Choral singing, performance perception, and immune system changes in salivary immunoglobulin A and cortisol. *Music Perception, 18,* pp. 87-106.

Clift S. M. and Hancox G. (2001). The perceived benefits of singing: Findings from preliminary surveys of a university college choral society. *Journal of the Royal Society for the Promotion of Health, 121,* pp. 248-256.

Cohen G. D., Perlstein S., Chapline J., *et al.* (2006). The impact of professionally conducted cultural programs on the physical health, mental health, and social functioning of older adults. *The Gerontologist, 46,* pp. 726-734.

Harré R. (1972) *The Philosophies of Science*. Oxford: Oxford University Press.

Hawthorne G., Herrman H., and Murphy B. (2006). Interpreting the WHOQOL-Bref: Preliminary population norms and effect sizes. *Social Indicators Research, 77,* pp. 37-59.

Houston D. M., McKee K. J., Carroll L., and Marsh H. (1998). Using humour to promote psychological wellbeing in residential homes for older people. *Aging and Mental Health, 2,* pp. 328-332.

Kreutz G., Bongard S., Rohrmann S., *et al.* (2004). Effects of choir singing or listening on secretory immunoglobulin A, cortisol and emotional state. *Journal of Behavioral Medicine, 27,* pp. 623-635.

Power M., Harper A., Bullinger M., and The World Health Organization Quality of Life Group (1999). The World Health Organization WHOQOL-100: Tests of the universality of quality of life in 15 different cultural groups worldwide. *Health Psychology, 18,* pp. 495-505.

Silber L. (2005). Bars behind bars: The impact of a women's prison choir on social harmony. *Music Education Research, 7*, pp. 251-271.

Skevington S., Lofty M., and O'Connell K. A. (2004). The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial. A Report from the WHOQOL Group. *Quality of Life Research, 13,* pp. 299-310.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The effects of the menopause and the use of hormonal replacement therapy on the female professional voice users' perceptions

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During the menopause, concentrations of estrogens and progesterone fall significantly, and the ratio of estrogen to androgen becomes androgen dominant. Elevated concentrations of androgens have been associated with negative effects on female voices. For those women whose careers depend on their voices, even mild vocal changes may significantly affect professional wellbeing and quality of life. This research explores female professional voice users' perceptions of vocal variations associated with the menopause and hormone replacement therapy (HRT) use, as well as implications for career management and professional wellbeing. Semi-structured interviews were carried out with five post-menopausal female professional voice users with different vocal backgrounds. Questions focused on (1) vocal quality, (2) self-identity and self-esteem, (3) career management, (4) professional quality of life and general wellbeing, and (5) opinions and feelings toward HRT use. The results highlight the importance of undertaking further research on the effects of climacteric hormonal variations and HRT use on the professional voice. With our ageing population, it is likely that more menopausal women will seek to maintain effective communication skills across their careers, with those whose careers depend on their voices meriting special concern.

Keywords: menopause; hormone replacement therapy; professional voice user; vocal, psychological, and sociological wellbeing

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Thematic session: Learning and Teaching I

International Symposium on Performance Science
ISBN 978-90-9022484-8

Diary of a child musical prodigy

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This study involves a longitudinal investigation of an exceptionally talented 10-year old female pianist who was first interviewed when she had just turned 7 years of age. The research attempts to document a range of factors that impact on the child's learning. Of particular interest are the child's personal learning agenda which guides her mastery of difficult repertoire and the support she receives from her parents and significant others. Associated areas of investigation include her exceptional aural and memorization skills and her ability to master challenging repertoire either by ear or from notation. The self-regulated strategies she employs to monitor and control her learning, especially during the preparatory stages when she is about to start learning new repertoire and the methods she uses when practicing, are also areas that are being investigated.

Keywords: prodigy; giftedness; talent; performance; memory; ability

The discipline of music psychology has flourished as a result of the many intriguing questions surrounding the nature of musical ability and how musical potential can be developed. No single area of research has created more discussion and controversy however, than debates focusing on the degree to which exceptionally talented musicians are the result of genetic predispositions (nature) or environmental stimulation through systematic training and practice (nurture). A major contribution to the debate acknowledging innate abilities comes from the extensive literature in the gifted and talented educational domain which suggests that child prodigies (i.e. extreme versions of gifted children) differ from average children in three ways. First, they are *precocious*, in that they are able to master information and tasks earlier and easier. Second, they *march to their own drummers,* by making discoveries on their own and solving problems intuitively rather than through logical, linear steps. Finally, they are driven by a *rage to learn*, which is evidenced in their ability to devote high attentional resources when engaged in learning, sometimes at the cost of losing sense of the outside world (Winner 1996). In line with this perspective, McPherson and Williamon (2006) have adapted Gagné's (2003) *Differentiated Model of Giftedness and Talent* to music, as a means of explaining the range of natural innate abilities, intrapersonal forces and environmental catalysts that impact on the development of musical skills. This conception defines *gifts* (e.g. intellectual, creative, socio-affective, sensori-motor) as natural innate potentials to achieve and *talent* as observable skills and proposes that although many seemingly natural potentials such as physical and mental dexterity, musicality, motor memory, and auditory memory are all evident in the first few weeks of formal musical training, each needs to be refined and developed further through extensive practice and learning for children to develop their musical talents.

From an environmental perspective, it can be argued that talent results not from cognitive abilities but from human characteristics such as temperament and personality which act in combination with a great deal of environmental stimulation through *deliberate practice* and ongoing, systematic training (Howe 1999, Gross 2005). Aligned with this perspective is literature suggesting that atypical development of the type displayed by child prodigies is highly influenced by interactions with significant others, especially parents (Mareschal *et al.* 2007, McPherson *in press*) and that these social dynamics result in the child developing particular neural structures which make further musical development much easier (Altenmüller and Gruhn 2002, Hodges 2006).

Vandervert and Liu (in press) have proposed that prodigies possess domain-specific high attentional control that begins in infancy to produce a spontaneous version of deliberate practice. This explanation shows how the child prodigy's working memory becomes faster, more concentrated, and more efficient and frames the role of both innate abilities and environmental stimulation because it shifts the explanation for these remarkable individuals "to the *reciprocal* learning relationships between the anticipatory, *adaptive* cognitive-affective and attentional modeling functions of the cerebellum and those of the cerebral cortex." This conception is similar to Shavinina (in press) who proposes that sensitive periods in the children's early years provide the foundations for giftedness, in that they accelerate the gifted child's mental development through the actualization of intellectual potential and cognitive experience.

This study involves a longitudinal investigation of an exceptionally talented young pianist who was first interviewed when she had just turned 7.

She is now 10 years of age. The research attempts to document a range of factors that impact on the child's learning. Of particular interest are the child's personal learning agenda which guides her mastery of difficult repertoire and the support she receives from her parents and significant others. Associated areas of investigation include her exceptional aural and memorization skills and her ability to master challenging repertoire either by ear or from notation. The self-regulated strategies she employs to monitor and control her learning, especially during the preparatory stages when she is about to start learning new repertoire and the methods she uses when practicing, are also areas that are being investigated.

METHOD

Procedure

To this point, the case study has involved face-to-face interviews with the child and her parents, ongoing communication with the child's mother, and viewing of videotaped performances of the child playing pieces and practicing over a period of three years. Although the research is ongoing with many parameters remaining to be analyzed, it is clear that the young learner displays outstanding potential as a musician. She has already developed to an international level of achievement on piano as compared to others of her age and shows the potential to continue developing at an equally rapid rate during the coming years.

RESULTS

When I first met with the child and her parents, she was 7 years old. I sought information according to two important areas. First, I was interested to know how she had become interested in music. Second, I wanted to know more about the informal learning experiences that had occurred since her first formal engagement with music. Watching her perform during this first session, I was struck by her remarkable abilities, which include the capacity to perform complete piano sonatas that she had learned entirely by ear as well as her ability to comprehend and read pieces from notation.

At about 2 years of age, the child was given a plastic toy piano. Her parents report that she would often sit at the toy piano and try to imitate melodies which she heard on the TV and a hi-fi her father had built with a friend at that time. Her father reports also that she would accompany him to purchase piano recordings that they would listen to on his stereo, and that she preferred purchasing CDs rather than going to a toy shop.

At age 4.5, the child began taking formal lessons on piano and by 7 was practicing up to 3 or even 4 hours per day and was capable of performing Grade 8 Associate Board repertoire. At 7 years of age, she was doing less practice (about 1 or 2 hours per day), partly because of the difficulty of finding a teacher who could cater for her unique learning curve, but also because she was more involved at school and needed to do more homework after school. More recently, the child has moved with her mother from Hong Kong to the United States in order to study at a prestigious school of music.

At our first meeting, I was informed that the young child had received lessons from a number of different teachers but that these had typically been only for a short period of time and that the parents had not been able to find anyone with whom the child felt comfortable learning. Most importantly, there appeared to be a distinct difference between the young child's learning agenda and those of her teachers. She displayed superb self-regulatory skills for her age, in that she would often listen to CD recordings of piano repertoire before choosing those works that she wanted to learn. This typically involved listening to the work on CD for a few weeks before then attempting to start learning the piece on the piano. Consequently, this young learner's strategy for learning new repertoire involved developing a clear mental image of the work she was about to learn well before physically attempting to master the work on the piano. One of the reasons why teachers were unable to satisfy this young learner's learning agenda is that they would typically attempt to take her back to basics rather than help her find the most efficient fingerings for the repertoire which she was attempting to master. Her *rage to master* was not related to the technique of playing the piano but rather what needed to be done in order to master the repertoire which she already knew from recordings and wanted to learn on the piano.

Without any question, a key influence in the child's learning has been the support and encouragement she has received from her parents. Neither parent has had any previous formal musical training. In line with existing evidence (McPherson *in press*), her mother reports sitting with her daughter during the early months of the child's learning and playing games that helped focus the young musician on repetition and mastery. One of the more successful strategies, according to the mother, was to say: "Can you play that piece again five times correctly?" "Can you play it 10 times correctly" "Now, can you play the piece 50 times correctly?"

During our meeting two years later, the child had improved significantly, but it was becoming clear that she needed to find a good teacher who could help her cope with a number of technical problems that were impacting on her development. About this time, her mother investigated the possibility of studying at leading institutions overseas, and the family made a decision that the mother would move with the child to a large city in the United States where she could take up a scholarship at an internationally renowned music school. The child has now completed one full year of study at this institution and made rapid progress, evidenced by her invitations to perform with orchestras. She has also won competitions and gained national recognition, through articles published in newspapers such as the *New York Times*.

During the presentation, videotaped excerpts of the child playing at the ages of 7, 9, and 10 will be shown, in order to document how the young girl has developed and how her learning curve is distinctly different from the majority of children who learn piano.

DISCUSSION

Current explanations of child prodigies suggest an interactive, dynamic model for explaining how their exceptional achievement in music develops as a result of environmental forces acting together with innate potentials at critical moments in the child's development. Implications for teaching and for understanding musical giftedness and talent will be discussed in the final part of the presentation which will also outline plans for future data collection and for documenting the child's musical development now that she is exposed to a highly competitive environment and world-class teaching.

Overall, there is much to learn from this remarkable young pianist. Her sense of musicianship, love for music, and the learning strategies that she uses to master difficult repertoire causes us to reflect critically on the efficiency with which other children typically learn instruments. My previous research has focused on the development of visual (performing rehearsed music, sight-reading), aural (playing from memory and by ear), and creative (improvising) aspects of performance, and the results of these studies has convinced me that typical teaching concentrates far too much on visual orientations to the exclusion of aural and creative facets of development (McPherson and Gabrielsson 2002). What I find intriguing about the child pianist described here is that she has naturally, effortlessly, and largely without formal teaching, been able to develop her ability to learn music by ear and to perform difficult repertoire from memory and from notation. Her distinctive learning curve is exemplified by a high degree of purposefulness and autonomy in her practice and performances that project a sense of style and musical understanding that normally becomes evident at a much later age. These attributes distinguish her from the majority of children who take up music. They are also the attributes that I intend to study further, in my attempts to chronicle the life of this extraordinarily talented young musician.

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References

Altenmüller E. and Gruhn W. (2002). Brain mechanisms. In R. Parncutt and G. E. McPherson (eds.), *The Science and Psychology of Music Performance: Creative Strategies for Teaching and Learning* (pp. 63-81). Oxford: Oxford University Press.

Gagné F. (2003). Transforming gifts into talents: The DMGT as a developmental theory. In N. Colangelo and G. A. Davis (eds.), *Handbook of Gifted Education* (3rd ed., pp. 67-74). Boston: Allyn and Bacon.

Hodges D. A. (2006). The musical brain. In G. E. McPherson (ed.), *The Child as Musician: A Handbook of Musical Development* (pp. 51-68). Oxford: Oxford University Press.

Howe M. (1999). *Genius Explained*. Cambridge: Cambridge University Press.

Mareschal D., Johnson M. H., Sirois S., *et al.* (2007). *Neuroconstructivism: How the Brain Constructs Cognition* (vol. 1). Oxford: Oxford University Press.

McPherson G. E. (in press). The role of parents in children's musical development. *Psychology of Music*.

McPherson G. E. and Gabrielsson A. (2002). Sound before sign. In R. Parncutt and G. E. McPherson (eds.), *The Science and Psychology of Music Performance: Creative Strategies for Teaching and Learning* (pp. 99-116). Oxford: Oxford University Press.

McPherson G. E. and Williamon A. (2006). Giftedness and talent. In G. E. McPherson (ed.), *The Child as Musician: A Handbook of Musical Development* (pp. 239-256). Oxford: Oxford University Press.

Shavinina L. V. (in press). When child prodigies, unique representations, and the extracognitive combine: Toward a cognitive-developmental theory of giftedness. In L. V. Shavinina (ed.), *The International Handbook on Giftedness*. Amsterdam: Springer Science and Business Media.

Vandervert L. R. and Liu H. (in press). How working memory and the cognitive cerebellum collaboratively produce the child prodigy. In L. V. Shavinina (ed.), *The International Handbook of Giftedness*. Amsterdam: Springer Science and Business Media.

Winner E. (1996). *Gifted Children: Myths and Reality*. New York: Basic Books.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The influence of the wider context of learning, gender, age, and individual differences on adolescent musicians' performance anxiety

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To date, most research on musical performance anxiety has focused on adult professional musicians, disregarding how anxiety might affect younger performers. As a result, a clear understanding of how it develops in adolescent musicians and which performers are more prone to it has not yet been established. The aim of this study was to explore the influence of the wider cultural context of learning, gender, age, and individual differences on adolescent musicians' experiences of performance anxiety as evidenced through their self reports on a newly-developed self-report questionnaire and the Adolescent Musicians' Performance Anxiety Scale (AMPAS). Participants included 410 young musicians between the ages 12-19 in two geographical locations (UK and Cyprus). Results from statistical analyses suggest that the wider context of learning, gender, age, personal characteristics, and individual differences arising from self-concept, self-efficacy beliefs, susceptibility to situational factors in performance, and parental expectations should be taken into account when assessing performance anxiety in adolescent musicians and within educational settings.

Keywords: performance; anxiety; measurement; prediction; adolescents

A number of studies examining professional and higher education student musicians have indicated that performance anxiety can negatively affect the quality of performance (Fishbein *et al.* 1988, Schulz 1981, Wesner *et al.* 1990). Musical performance anxiety seems to be a critical problem for 15% to 25% of musicians (Steptoe 2001). Musicians of different musical genres seem to have different performance anxiety experiences, with classical musicians appearing to be more anxious compared to musicians of other-than-classical genres (jazz, popular, and Scottish traditional music) (Welch *et al.* 2006). To date, most research has focused on adult professional musicians, disregarding how anxiety might affect younger performers and how early experiences might affect anxiety in subsequent years. No clear understanding has yet been established of how performance anxiety develops in adolescent musicians, under what conditions and in which performers (Kenny and Osborne 2006).

The aim of this study was to explore the influence of the wider cultural context of learning, gender, age, and individual differences on adolescent musicians' experiences of performance anxiety as evidenced through their responses to a newly-developed self-report questionnaire and the Adolescent Musicians' Performance Anxiety Scale (AMPAS; Papageorgi 2007).

METHOD

Participants

Four hundred and ten students participated in the study. Of these, 51.5% were Cypriot-based and 48.5% were British-based students; 57.8% of the participants were female, and 42.2% were male. Ages of the participants ranged from 12-19 years, with the mean age at 15.33 years. All students were attending junior conservatoires and/or youth orchestras. Instruments that participants played included the piano/keyboard, string, woodwind, brass, and percussion instruments, guitar, voice, bouzouki, and harp.

Materials

A newly-developed self-report questionnaire was used to gather information on a range of learning and performance issues (see Papageorgi 2007). A scale measuring performance anxiety levels was also developed, as no other performance anxiety instrument focusing on adolescent musicians existed in the literature. The Adolescent Musicians' Performance Anxiety Scale (AMPAS; Papageorgi 2007) included twenty items that dealt with maladaptive performance anxiety related issues, such as negative outcome expectancies, negative experiences in performance, evidence of pre-evaluation anxiety, experience of physiological symptoms of anxiety, concern about others' judgment and negative perception of anxiety. The design of the scale followed recognized criteria for the development of psychometric tests (see Papageorgi 2007). Measures of internal consistency after the main data collection were highly satisfactory (Cronbach α=0.86).

Procedure

Statistical analyses were carried out on the data obtained from the questionnaire and the AMPAS: (1) a 3-way analysis of variance (ANOVA) was

Table 1. Descriptive statistics on performance anxiety groups.

	Score range	*Whole sample (n=410)*	*Cypriot students (n=211)*	*British students (n=199)*
Highly anxious students	74-100	10.8	15.0	6.3
Moderately anxious students	47-73	69.3	70.0	68.4
Low anxious students	20-46	19.9	15.0	25.3

conducted to evaluate the effects of nationality, gender, and age on students' total score on the AMPAS, (2) a stepwise multiple regression was conducted with musicians' AMPAS score as the dependent variable, and (3) a discriminant function analysis was conducted to determine which variables differentiated between anxiety groups as measured by the AMPAS. For the purposes of the discriminant analysis, students were placed into one of three anxiety groups according to their overall score on the AMPAS (see Table 1).

RESULTS

Influence of the wider context of learning, gender, and age

A 3-way ANOVA was conducted to evaluate the effects of the wider context of learning, gender, and age on students' total score on the AMPAS. The wider context of learning was represented by the location in which students received their music education and developed as musicians and "nationality" was used to denote this. Results indicated a significant main effect for nationality, $F(1,349)=14.44$, $p<0.0001$, partial $\eta^2=0.04$, and gender, $F(1,349)=14.87$, $p<0.0001$, partial $\eta^2=0.04$. Cypriot students had a higher score on the AMPAS (mean=60.06, SD=13.46) compared to British students (mean=54.63, SD=11.17), and female students appeared to be more anxious (mean=59.68, SD=13.18) compared with male students (mean=54.53, SD=11.42). A significant interaction was found between nationality and age group, $F(1,349)=8.45$, $p<0.005$, partial $\eta^2=0.02$. British students were more anxious as they became older: 12-15 years (mean=51.95, SD=10.01), 16-19 years (mean=57.43, SD=11.69). The opposite was the case for Cypriot students: 12-15 years (mean=61.18, SD=14.19), 16-19 years old (mean=58.88, SD=12.61). There was no significant effect for age group or any other significant interactions.

Table 2. Contribution of individual variables in prediction of total score on the AMPAS.

	β weight	*t-value*
Low perceived level of anxiety	-0.34	-8.63***
Experience of heightened anxiety in the presence of an audience	0.29	6.70***
Positive self-concept in music	-0.13	-3.36**
Sensitivity to degree of self-exposure	0.12	3.18**
Low self-efficacy in music	0.10	2.75**
Effect of environment quality on anxiety levels	0.10	2.80**
Nationality	-0.10	-2.69**
Perfectionism	0.10	2.78**
Perception of critical parents with high expectations	0.09	2.46*

* $p<0.05$, ** $p<0.01$, *** $p<0.0001$

The prediction of musical performance anxiety

A stepwise multiple regression was conducted with musicians' AMPAS score as the dependent variable. The regression model was statistically significant, $F(9,338)=59.93$, p<0.0001. The effect size, as calculated by the multiple R, was 0.78, $R^2=0.62$ and adjusted $R^2=0.60$, indicating that the model explained 60% of the variance. Contributions of individual predictors are summarized in Table 2.

Variables differentiating between anxiety groups

Discriminant function analysis was conducted to determine which variables differentiated between the three performance anxiety groups (low, moderately, and highly anxious) as measured by the AMPAS. Two discriminant functions were calculated, with a significant overall Wilk's lambda ($\Lambda=0.52$, $\chi^2(36)=183.22$, $p<0.0001$). After removing the effects of the first function, the second discriminant function did not reach statistical significance. The first function had an eigenvalue of 0.81 and a canonical correlation of 0.67; η^2 was 0.45, indicating that 45% of the variability of the scores was accounted for by differences among the three groups. Correlations between predictors and discriminant function are shown in Table 3.

DISCUSSION

Findings indicate that the wider context of learning and gender is an important influence on performance anxiety. Age, in itself, did not appear to

Table 3. Correlations between predictor variables and functions.

	Function 1
Low perceived level of anxiety	-0.68*
Experience of heightened anxiety in the presence of an audience	0.64*
Sensitivity to degree of self-exposure	0.46*
Low self-efficacy in music	0.35*
Positive self-concept in music	-0.32*
Perception of receiving positive feedback from teacher	-0.31*
Perfectionism	0.29*
Effect of performance environment quality on anxiety levels	0.28*
Concern about others' responses to playing	0.24*
Entity theory of ability	0.17*
Effort in practice	-0.23
Intrinsic motivation to learn a musical instrument	-0.12
Perception of supportive and encouraging parents	0.06
Perception of being under pressure to continue with music lessons	0.11
Development of musical identity	-0.16
Incremental theory of ability	0.06
Perception of critical parents with high expectations	0.08
Negative perception of anxiety	0.10

* Largest absolute correlation between each variable and any discriminant function.

be a key factor. A significant proportion of the participant musicians (over 10%) experienced considerable levels of maladaptive performance anxiety.

Results from the regression analysis suggested that anxiety level could be predicted by (a) students' self-perceptions, as evidenced by their perceived level of anxiety, self-concept, self-efficacy, and perfectionism, (b) situational parameters such as the influence of audience presence, the degree of self-exposure and the influence of the venue, (c) the wider cultural context of learning, evidenced by nationality, and (d) family environment, evidenced by parental attitudes toward the student.

The discriminant analysis revealed one significant function, which differentiated highly anxious performers from the other musicians and was related to the experience of maladaptive musical performance anxiety. Highly anxious performers acknowledged themselves as being highly anxious. Their anxiety was influenced by situational parameters such as audience presence, high self-exposure, and performance environment quality. They held negative views of themselves and their ability (had negative self concept and low self-efficacy), perceived the feedback they received negatively, expressed concern over others' responses to their playing, and put less effort into practicing.

Overall, research findings support earlier literature relating to the identification of factors affecting performance anxiety. This research is unique in considering these factors collectively in adolescents and ascribing weightings to each. Findings highlight the importance of understanding how performance anxiety affects individual musicians and of a personal assessment of anxiety susceptibility when planning for performance. Individual characteristics shaping anxiety vulnerability should be taken into account in educational contexts so that we can successfully support musicians as they cope with performance anxiety and maintain wellbeing.

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References

Fishbein M., Middlestadt S. E., Ottati V., Strauss S., and Ellis A. (1988). Medical problems among ISCOM musicians: Overview of a national survey. *Medical Problems of Performing Artists*, *3*, pp. 1-8.

Kenny D. and Osborne M. S. (2006). Music performance anxiety: New insights from young musicians. *Advances in Cognitive Psychology*, *2*, pp. 103-112.

Papageorgi I. (2007). *Understanding Performance Anxiety in the Adolescent Musician*. Unpublished doctoral thesis, Institute of Education, University of London.

Schulz W. (1981). Analysis of a symphony orchestra. In M. Piperek (ed.), *Stress and Music: Medical, Psychological, Sociological, and Legal Strain Factors in a Symphony Orchestra Musicians Profession* (pp. 35-56). Vienna: Wilhelm Braumuller.

Steptoe A. (2001). Negative emotions in music making: The problem of performance anxiety. In P. N. Juslin and J. A. Sloboda (eds.), *Music and Emotion: Theory and Research* (pp. 291-307). Oxford: Oxford University Press.

Welch G., Duffy C., Potter J., and Whyton T. (2006). *Investigating Musical Performance (IMP): Comparative Studies in Advanced Musical Learning*. Institute of Education, University of London, Funded by the ESRC/TLRP, RES-139-25-0258.

Wesner R. B., Noyes R., and Davis T. L. (1990). The occurrence of performance anxiety among musicians. *Journal of Affective Disorders*, *18*, pp. 177-185.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Composing with *Hyperscore* in general music classes: An exploratory study

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This paper presents the first report of an exploratory study involving the use of the software *Hyperscore* in general music classes as a mean to facilitate musical understanding and conceptual transferability from a technology mediated music learning context to the normal music classroom setting. It was developed in one school in three classes of 26 children each, 10 to 13 years old, in the context of pre-service music teacher training under the supervision of the Department of Music Education of the Porto College of Education. Between December 2006 and May 2007, the three classes were involved in music education both in a room provided with one computer with headphones for each child and the software *Hyperscore*, and in the normal music classroom environment. Using mainly a qualitative, exploratory, and participant research methodology, data collected involved children's files and evaluation sheets, teachers' written observations, and interviews. Preliminary findings reveal high levels of task centered behavior, autonomy, and collaborative attitudes, as well as a more conscious use of musical vocabulary. Given the strong appeal of the graphical composition system, further studies are needed in order to establish a clear link between the child's musical intentions and the pictographic outcomes.

Keywords: composition; technology; transferability; motivation; autonomy

While in the last decades there has been a growing interest in the use of information and communication technologies (ICT) in music classes, the number and conceptual scope of detailed research, including the use of ICT in classroom-based music education, are rare. The body of literature in this area outlines, on the one hand, the implications of music technology for curriculum development (Hunt and Ross 1997, Rogers 1997, Savage and Challis 2002, Cain 2004, Finney and Burnard 2007, Brown 2007), and on the other, the fundamental relationship between ICT and the activity of composing in the classroom (Dalgarno 1997, Savage and Challis 2001, Savage 2005). As a good endeavor toward an informed reflection on this matter, the *British Journal of Music Education* dedicated in 1997 an entire issue to the use of technology in music education. In its opening editorial, John Paynter wrote (1997, p. 108):

> We are reminded frequently that IT is a *means* not and end, supporting "the quest for genuinely musical activities...." It offers "opportunities to explore different timbres" and to create "individual interpretations" of music.... These are the thoughts to keep in mind.... Used imaginatively—and, it is to be hoped, free of the unhelpful jargon—this is not IT for IT's sake but rather "technology *in the service of music*" [original italics].

Paynter's great concern that the use of ICT in music education could ignore that music exists in the direct relationship with its production (its instruments, literature, notation systems) makes real sense as the danger exists that ICT comes into the music education classroom without a previous conceptual grasp of its true potential as a mean of challenging "the very nature of music itself at a fundamental level" (Savage 2005). It is also in the very specific domains of composing and performing as musical *activities* that we are concerned to situate this study, placing music as a curriculum subject where ICT cannot be envisioned as an end in itself but as a mean to set free imagination and creativity (Paynter 2000).

Most recently, composers and music educators (Jennings 2003, 2005, Farbood *et al.* 2004, Machover 2004) have been joining efforts and working "to bring together sophisticated and attractive new music, participatory musical activities that stimulate the creative imagination...and innovative concepts about pedagogy and healing, to lay the foundations for a new field of 'active music'" (Machover 2004, p. 171). The result of this work is partially made concrete through the *Hyperscore* software designed as a graphical sketchpad for novice composers. The present study aims to explore the use of this particular software as a mean to facilitate musical understanding, with the objective of comprehending how music conceptual transferability from a technology mediated music learning context to the traditional music classroom setting, and vice-versa, is operated by children.

METHOD

Participants

This research study was developed in the S. Mamede de Infesta Secondary School, Porto. It involved three classes of 26 children each, 10-13 years old, in the context of pre-service music teacher training under the supervision of the Department of Music Education of the Porto College of Education.

Materials

The project took place both in the normal music room (provided with a piano, a number of Orff instruments and acoustic guitars) and in a room equipped with 28 computers where the software *Hyperscore* had been previously installed, individual headphones, a multimedia projector, and a screen. The software was designed by Mary Farbood and Egon Pazstor at the MIT lab (Cambridge, Massachusetts, USA), with the collaboration of Kevin Jennings, specifically with the intention to facilitate composition activities for beginners at all ages. It consists of a working space containing two types of "window," which are usually referred as the "motive" window and the "sketch" window. Basically, motives, which are color coded, are made by placing notes in the motive window, which will then be placed in the main sketch window by a process of "drawing" them in with the appropriate color pen. The compositional process in this environment is based on the idea that participants arrive at a final piece of music by putting together a number of previously created motives.

Procedure

In December 2006, all children received tuition in one 90-minute experimental session with the software *Hyperscore (H)* in a room provided with one computer with headphones for each child. Between January and May, 2007, the three classes were involved in music education in the following ninety-minute sessions scheme: two *H*, two sessions of normal music classroom *(C),* two *H*, one *C*, four *H*, and five *C*. All sessions were designed and taught by three pre-service music teachers in the presence of the cooperating music teacher. Furthermore, there was the partial intervention of the music supervisor from the College of Education and of a music technology specialist.

The composition tasks took into account both the need to explore freely the software and make the children acquainted with its possibilities and the Portuguese music curriculum in terms of melodic, harmonic, and structural musical development in the direct relationship with music making. Further tasks were to perform on acoustic instruments some of their *H* compositions and, conversely, transcribe a previously learned Portuguese folksong to the *H* environment.

It was assumed that a qualitative, exploratory, and participant methodology was the most appropriate for both the research context and the analysis of the data, which involved children's files, evaluation sheets during the composition process, teachers' written observations, and interviews.

RESULTS

This preliminary report is based on written observations that were gathered in four main categories of analysis: (1) attitudes and values, (2) music conceptual development, (3) contemporary music, and (4) graphical composition system.

Attitudes and values. All children, while working in the *H* environment, revealed high levels of motivation, task centered behavior, autonomy, and collaborative attitudes towards their peers.

Music conceptual development. It was observed that the use of musical vocabulary by the children, when working in the *C* environment, had been improved and seemed to reveal a greater consciousness of meanings for concepts such as melody, rhythm, and harmony. Both in the process of performing the *H* compositions in the music classroom and in transcribing the Portuguese folksong to the *H* environment, an enhanced capacity to deal with music concepts was observed.

Contemporary music. When listening to contemporary music, children showed a greater awareness and tolerance toward dissonance than should be expected at this age level.

Graphical composition system. The fact that the power of the graphical composition system appeared to be so strong in terms of its visual appeal was perceived as a major critical point. Clearly, in many observed moments children's motives were the result of a graphical/visual process rather than a reflection of musical intent (see Figure 1).

DISCUSSION

Taking into account that the study was developed in the context of a fairly high number of children in each classroom, it is noticeable the change in the field of attitudes and values when working in the *H* environment. The findings also point to an apparent musical gain in terms of conceptual development. Bearing in mind the theoretical concern previously formulated

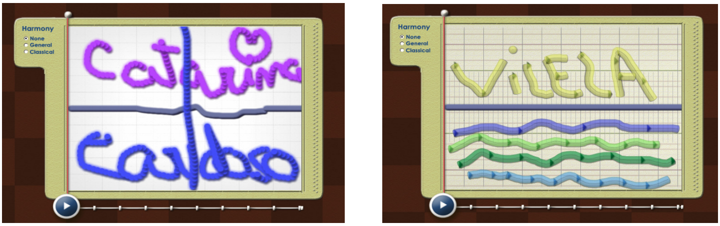

Figure 1. Two motives with children's names.

according to Paynter (1997, 2000), the child's autonomy while composing in the *C* environment, as opposed to composing in the *H* environment, deserves further attention as the domain where transferability can be observed and conceptualized. Moreover, the relationship between graphic notation in the *H* environment and conventional and non-conventional notation in the *C* environment could profit from further studies that help to establish how far the graphical system of this software acts as a vehicle for conveying the child's musical intentions.

Acknowledgments

We acknowledge the support of Casa da Música and of the secondary school in S. Mamede de Infesta, which made possible the development of this project.

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References

Brown A. R. (2007). *Computers in Music Education: Amplifying Musicality*. London: Routledge.

Cain T. (2004). Theory, technology and the music curriculum. *British Journal of Music Education*, *21*, 215-221.

Dalgarno G. (1997). Creating an expressive performance without being able to play a music instrument *British Journal of Music Education*, *14*, 111-117.

Farbood M., Pasztor E., and Jennings K. (2004). Hyperscore: A graphical sketchpad for novice composers. *IEEE Computer Graphics and Application*, *Jan-Feb*, 50-54.

Finney J. and Burnard P. (eds.) (2007). *Music Education with Digital Technology*. London: Continuum.

Hunt A. and Ross K. (1997). Technology and music: incompatible subjects? *British Journal of Music Education*, *14*, 111-117.

Jennings K. (2003). "Toy symphony": An international music technology project for children. *Music Education International*, *2*, 3-21.

Jennings K. (2005). Hyperscore: A case study in computer mediated music composition. *Education and Information Technologies*, *10*, 225-238.

Machover T. (2004). Shaping minds musically. *BT Technology Journal*, *22*, 171-179.

Paynter J. (1997). Editorial. *British Journal of Music Education*, *14*, 108.

Paynter J. (2000). Making progress with composing. *British Journal of Music Education*, *17*, 5-31.

Rogers K. (1997). Resourcing music technology in secondary schools. *British Journal of Music Education*, *14*, 111-117.

Savage J. and Challis M. (2001). Dunwich revisited: Collaborative composition and performance with new technologies. *British Journal of Music Education*, *18*, 139-149.

Savage J. and Challis M. (2002). A digital arts curriculum? Practical ways forward. *Music Education Research*, *4*, 7-23.

Savage J. (2005). Working towards a theory for music technologies in the classroom: How pupils engage with and organise sounds with new technologies. *British Journal of Music Education*, *22*, 167-180.

Thematic session: Perceiving performance

International Symposium on Performance Science
ISBN 978-90-9022484-8

Intended versus perceived emotion

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This paper reports the preliminary results of an activity involving the communication of intended and perceived emotions. Six male students were requested to present their interpretation of the piece *Tempo Livre* (Free Time) after practicing for ten days. The participants were instructed to mobilize their store of musical procedural knowledge in order to convey an intended emotion. Eight other students were requested to write down their perception of each of the six individual performances. Results show that communication does not correlate with years of musical study and that there is a pointed divergence between intended and perceived emotions.

Keywords: emotion; piano performance; communication; circumplex model

The expression of emotion in music performance is a form of nonverbal communication that elicits a wide variety of responses among listeners and participants. Emotion and music performance have been investigated under different perspectives. For instance, Peretz and Zatorre (2005) developed neuroimaging techniques in order to access relationships between emotion and performance in the brain. Mathematical algorithms (Zhu *et al.* 2006) and new computational models of interactive multimedia platforms (Leman and Camurri 2005) have been proposed as a means to model some aspects of emotion during performance. Juslin *et al.* (2006) evaluated a computer program that automatically analyzes music performances and provides feedback to musicians in order to enhance their communication of emotions. Schoonderwaldt *et al.* (2002) also proposed similar computer systems. Other researchers have focused on the relationship between the performer and the audience. Resnicow *et al.* (2004) found some correlations between the identification of emotion during music performance and everyday emotional intelligence. Other studies have pointed out the importance of both musical structure (Sloboda and Lehmann 2001) and the visual aspects in the perception of communicated expression (Vines *et al.* 2006).

According to Persson (2003), interpretative processes are very complex and intuitive. Most musicians tend to agree with this assertion, although they believe instrumental teaching and learning should not lack a systematic approach which enhances the communication of emotion. Some researchers have confirmed that professional musicians are capable of communicating specific emotions to the audience (Juslin 2000, Juslin and Madison 1999, Gabrielsson and Juslin 1996). On the other hand, in the case of amateurs, Juslin and Laukka (2000) observed that the level of accuracy is lower than that of experts; however, accuracy can be improved by appropriate feedback. Thus, as far as instrumental teaching is concerned, it seems relevant to investigate the degree of deliberation and intentionality of emotion that is to be communicated. Although expressivity is a fundamental aspect of music performance, music instruction tends to privilege mechanical prowess. Throughout our music practice with students at all levels, we have found that communicative skills must be developed along with instrumental expertise.

The present paper reports some preliminary results about communicated intentional emotions and the perceived emotions by a musically educated audience. The piano students used in this activity were both undergraduates and graduate students.

METHOD

Participants

A semester-long course with one two-hour weekly meetings and a lab was set up for undergraduate and graduate piano students at the Federal University of Rio Grande do Sul (UFRGS). This course allowed for diverse opportunities for both performance and discussion. For this particular activity, six males participated as performers and eight other students (male and female) were selected as listeners.

Materials

Tempo Livre (Free Time) is a short work from Jamary Oliveira's cycle entitled *Oito Peças* (Eight Pieces), written in 1966. The rhythmic organization is based on a proportional ratio of short and long values devoid of time signature. There are no indications for dynamics, nor any for articulations.

Table 1. Emotions intended by the performers and perceived by some listeners during the recording sections of *Tempo Livre* by Jamary Oliveira.

Performers		*Listeners*				
	Intentions	*1*	*2*	*3*	*4*	*5*
A	Anger	Decided	Instability	-	Sadness	Anger
B	Rude	Spontaneous	Agitated	Indifferent	Bad mood	Suspense
C	Anger	-	Anger	Crazy	Impatient	Hate
D	Astuteness	Affirmation	Determination	Determin.	Suspicion	Determin.
E1	Sadness	Romantic	Absorbed	Atmosphere	-	Serenity
E2	Transience	Hesitating	Restless	Cold	Joke	Anxiety
E3	Intolerance	Joke	Intense	Answered	The evil	Calm/tense
F	Sadness	Mournful	Mistrustful	Calm	Anger	Fear

Procedure

Six male students were requested to present their interpretation of the piece *Tempo Livre* (Free Time) after ten days of practicing. The participants were instructed to mobilize their store of musical procedural knowledge in order to convey an intended, deliberate emotion (mood, feeling, attitude, character) of their own choosing. The choices of intended emotions were not disclosed during the recording of the performances. Eight students were requested to write down their perception of each individual performance. The interpretations were recorded live.

RESULTS

In Table 1, the Performers (left column) are arranged in order of academic rank (undergraduate to graduate) and are labeled by letters. For instance, Performer A is a freshman enrolled in the undergraduate piano course, whereas Performer F is a second-year applied piano graduate student. For the sake of spontaneity, listeners were randomly numbered. Given the freedom allowed for the perceived emotions, the terms used to describe emotional intention range between adjectives and nouns. At no time did we try to restrain the responses. Table 1 reflects this diversity of the answers of some listeners.

Preliminary data were analyzed by a circumplex model of emotion from Russell (1980), which consists of a two-dimensional, circular structure involving activation and valence.

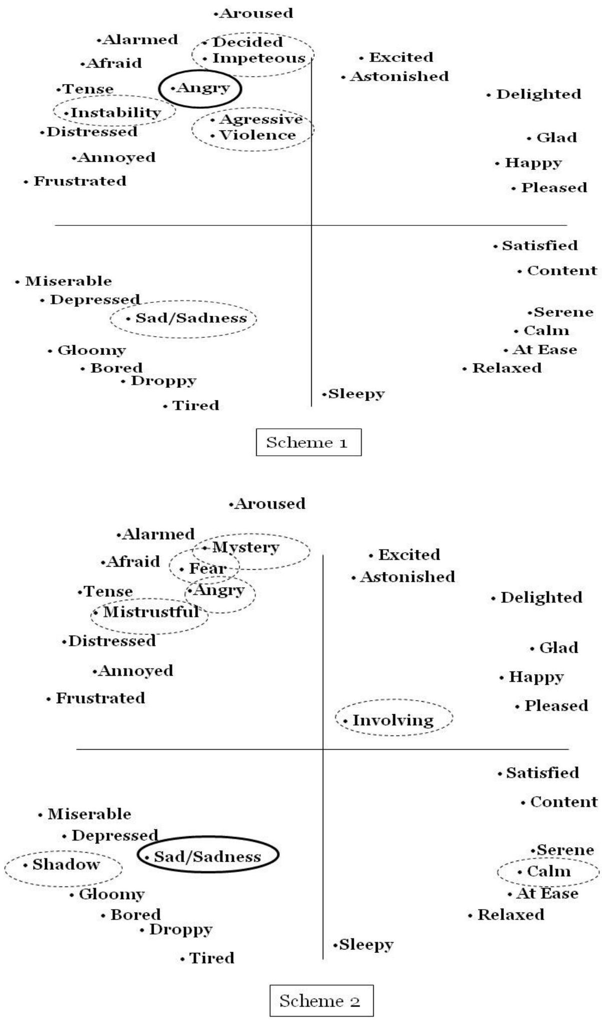

Figure 1. Application of Russel's (1980) Circumplex model. Scheme 1: Performer A (first semester undergraduate); Scheme 2: Performer F (second year graduate).

In Russel's Circumplex Model, activation corresponds to a physiological response (e.g. calm, tense, tired, excited), while valence accounts for mood or expression that captures the experience of emotion (e.g. happy, sad, angry).

Within this structure, emotions on opposite poles, such as sadness and happiness, correlate inversely. The circumplex model captures two important aspects: (1) emotions that vary in their degree of similarity and (2) certain emotions (e.g. happy, sad) that are often thought of as bipolar. In Figure 1, the two schemes represent the relation between intended emotion (continuous line) and perceived emotion (dashed line). For the undergraduate performers (Scheme 1), there is a high consensus between intended and perceived emotions. Scheme 2 shows a significant dispersion of perceived emotions. In other cases, for instance, for Performer D (recent graduate), the intended emotion, "astuteness, mixture of cleverness with determination," was perceived by three of the listeners as "determination" (see Table 1).

By comparing Schemes 1 and 2 (that of a junior and a second-year graduate piano student), it is possible to observe that years of study do not in and of itself guarantee success in communicating an intended emotion. The performer D (7^{th} semester undergraduate) was the most successful in transmitting the intended emotion (see Table 1).

There is a related point that concerns the rhythmic structure associated with well-defined physical gestures that are employed as a means of expressive communication. There is a high degree of correlation between stressed and non-stressed events throughout the performances.

DISCUSSION

Throughout the activity, it became clear to us that the students were eager to face the proposed challenges. One of them insisted on being recorded three times (see Performer E in Table 1). On the other hand, it also became clear that the free flow of emotion did not find correspondence in all instances. From the point of view of the performers, the perceived emotion varied so widely as to require a sobering—albeit partial—conclusion. The level of complexity revealed by the imprecision and subjectivity, as well as the idiosyncrasies shown in the descriptions (see Table 1) require further searching for methodological alternatives.

Acknowledgments

We gratefully acknowledge grants from the Brazilian Government agency CNPq.

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References

Gabrielsson A. and Juslin P. N. (1996). Emotional expression in music performance: Between the performer's intention and the listener's experience. *Psychology of Music, 24*, pp. 68-91.

Juslin P. N. (2000). Cue utilization in communication of emotion in music performance: Relating performance to perception. *Journal of Experimental Psychology: Human Perception and Performance, 26,* pp. 1797-1813.

Juslin P. N. and Laukka P. (2000). Improving emotional communication in music performance through cognitive feedback. *Musicae Scientiae, 4*, pp. 151-183.

Juslin P. N. and Madison G. (1999). The role of timing patterns in the decoding of emotional expressions in music performance. *Music Perception, 17*, pp. 197-221.

Leman M. and Camurri A. (2005). Understanding musical expressiveness using interactive multimedia platform. *Musicae Scientiae* , *Special Issue*, pp. 209-233.

Peretz I. and Zatorre R. J. (2005). Brain organization for music processing. *Annual Review of Psychology, 56*, pp. 89-114.

Persson R. (2003) The subjective world of the performer. In P. N. Juslin and J. A. Sloboda (eds.), *Music and Emotion* (pp. 275-289). Oxford: Oxford University Press.

Resnicow J. E., Salovey P., and Repp B. H. (2004). Is recognition of emotion in music performance an aspect of emotional intelligence? *Music Perception, 22*, pp. 145-158.

Schoonderwaldt E., Friberg A., Bresin R., and Juslin P. (2002). A system for improving the communication of emotion in music performance by feedback learning. *Journal of the Acoustical Society of America, 111*, pp. 2471-2481.

Sloboda J. A. and Lehmann A. C. (2001) Tracking performance correlates of changes in perceived intensity of emotion during different interpretations of a Chopin piano prelude. *Music Perception, 1*9, pp. 87-120.

Vines B. W., Krumhansl C. L., Wanderley M. M., and Levitin D. J. (2006) Cross-modal interactions in the perception of musical performance. *Cognition, 101*, pp. 80-113.

Zhu Z., Shi Y. Y., Kim H. G., and Eom K. W. (2006). An integrated music recommendation system. *IEEE Transactions on Consumer Electronics, 52*, pp. 917-925.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Golden Section in the sonatas of Domenico Scarlatti: An examination of Kirkpatrick's crux

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More than fifty years ago, performer-musicologist Ralph Kirkpatrick (1911-1984) observed a compositional phenomenon in the bi-partite sonatas of Domenico Scarlatti (1685-1757), which he termed "crux" or the point in each half where the thematic material at the ends of both halves establishes the closing tonality. The crux is thus a device with a triple function: melodic, harmonic, and structural. To date, there has never been systematic study of the position of the crux in the Scarlatti sonatas. Therefore, the main objective of this study is to examine the relationship of the position of the crux in two bodies of contrasting Scarlatti sonatas—the *Essercizi* (published 1738-1739) and the *Cantabile* sonatas—using the Golden Section (GS) as a measuring tool in order to determine (a) if GS exists and (b) if so, what are the implications.

Keywords: Golden Section; Kirkpatrick's crux; Domenico Scarlatti; proportion; sonatas

It is not uncommon that such authors who have written about compositional techniques in the Scarlatti sonatas (Benton 1952, Kirkpatrick 1953a, Halton 2002, Sutcliffe 2003, Harper 2005) have observed the wealth of inventive material that easily flowed from Scarlatti's imagination. So rich is this material that it often confounds classification (Clark 1976, Sheveloff 1985, 1986, Puyana 1987, Harper 2002), as well as chronological dating (Kirkpatrick 1953b, Longo 1906-1908, Pestelli 1967, Fadini 1978-1995). The Golden Section (GS) is a well-known proportional ratio used not only in architecture and music, but also found in Nature and in the human body (Murchie 1978, Howat 1986). The algebraic irrational number of GS is *phi*: $\varphi = (1+\sqrt{5})\div 2 \approx 1.6180339887\ldots$, with the geometric relationship being $(a+b)\div a = a\div b = \varphi$. Thus, the Scarlatti sonatas, by virtue of their bi-partite nature and crux, lend themselves quite naturally to this kind of scrutiny.

MAIN CONTRIBUTION

Domenico Scarlatti's *Essercizi* (*E*) consist of 30 works dedicated to King John V of Portugal and published in an oversized, kingly edition by Roseingrave in London (1738-1739) shortly after Scarlatti's knighthood. With a didactic objective of developing digital dexterity, 29 sonatas are marked *allegro* or *presto*, plus the final moderate "Cat" fugue, and are catalogued by Kirkpatrick as K. 1-30. Contrarily, Scarlatti's twenty *Cantabile* sonatas (*C*) do not belong to a specific collection but rather are interspersed throughout his *œuvre*, ranging from K. 77 to K. 546. Some are multi-tempied (K. 77, 170, and 176) and reveal Domenico's predilection for florid aria-like expression, lest we not forget that he was also a virtuoso singer (Doderer 1991).

Methodology and results

The following methodology was used: (1) selection of contrasting bodies of Scarlatti sonatas, (2) identification of the lengths of *A* and *B* halves in each sonata, (3) identification of the position of the crux in *A* and *B* of each sonata, and (4) comparison of the occurrence of the crux with GS (length multiplied by 0.618034). The results of these tabulations of GS-crux correspondence are indicated in Table 1.

Table 1. Essercizi and *Cantabile* sonatas.

Sonata	*Tempo (meter)*	*Length: A+B (in bars)*	*Crux: A, B (bar nos.)*	*GS (A, B); Crux (A, B)*
Essercizi				
K.1, D minor	Allegro (4/4)	13+18=31	7, 17	8, 03; 11, 12
K.2, G major	Presto (3/8)	37+41=78	21, 62 [25]	22, 87; 25, 34
K.3, A minor	Presto (2/2)	47+47=94	27, 77	29, 05; 29, 05
K.4, G minor	Allegro (4/4)	21+18=39	13, 30 [9]	12, 98; 11, 12
K.5, D minor	Allegro (3/8)	43+47=90	23, 70 [27]	26, 58; 29, 05
K.6, F major	Allegro (3/8)	37+38=75	31, 66	22, 87; 23, 49
K.7, A minor	Presto (3/8)	73+82=155	31, 121	45, 12; 50, 68
K.8, G minor	Allegro (3/4)	24+23=47	16, 41	14, 83; 14, 21
K.9, D minor	Allegro (6/8)	26+34=60	16, 50	16, 07; 21, 01

Key. Red: direct correspondence (DC); blue: close correspondence (+2 bars; CC), green: inverted correspondence (proportion of GS-crux between the halves; IC); [ ]=bar position in section; ( )=bar length variant due to first and/or second ending (See full color version at www.performancescience.org.)

Table 1 (cont.)

Sonata	*Tempo (meter)*	*Length: A+B (in bars)*	*Crux: A, B (bar nos.)*	*GS (A, B); Crux (A, B)*
K.10, D minor	Presto (3/8)	36+39=75	21, 45	22, 25; 24, 10
K.11, C minor	Allegro (4/4)	14+14=28	10, 24 [11]	8, 65; 8, 65
K.12, G minor	Presto (4/4)	24+24=48	19, 44	14, 83; 14, 83
K.13, G major	Presto (2/2)	54+59=113	29, 84	33, 37; 36, 46
K.14, G major	Presto (12/8)	19+24=43	12, 36 [17]	11, 74; 14, 83
K.15, E minor	Allegro (3/8)	54+58=112	28, 87	33, 37; 35, 85
K.16, B*b* major	Presto (2/2)	59+53=112	34, 91 [32]	36, 46; 32, 76
K.17, F major	Presto (3/8)	55+74=129	35, 104	33, 99; 45, 73
K.18, D minor	Presto (4/4)	27(28)+25(26)= 52(53)	18, 44 [16]	16, 69; 15, 45
K.19, F minor	Allegro (2/4)	38+54=92	16, 58	23, 49; 33, 37
K.20, E major	Presto (2/4)	64+38=102	37, 88 [24]	39, 55; 23, 49
K.21, D major	Allegro (3/8)	74+76=150	53, 129	45, 73; 46, 97
K.22, C minor	Allegro (2/4)	36+42=78	19, 63 [26]	22, 25; 25, 96
K.23, D major	Allegro (4/4)	32+38=70	14, 51-52	19, 78; 23, 49
K.24, A major	Presto (4/4)	36+30=66	20, 57	22, 25; 18, 54
K.25, F# minor	Allegro (2/4)	45+42=87	30, 75	27, 81; 25, 96
K.26, A major	Presto (3/8)	68+80=148	48, 121 [53]	42, 03; 49, 14
K.27, B minor	Allegro (3/4)	31+37=68	11, 47	19, 16; 22, 87
K.28, E major	Presto (3/8)	57+72=129	29, 100 [43]	35, 23; 44, 50
K.29, D major	Presto (4/4)	48+39=87	24, 66	29, 67; 24, 10
Cantabile				
K.77, D minor	Moderato e cantabile (3/4 and 3/8 Minuet)	17+30=47, 20 (13)+20=40; 47+40=87	11, 31; 60, 79 = 87	10, 51; 18, 54 (Cant.) 12, 37; 12, 37 (Minuet)
K.132, C major	Cantabile (3/4), Andante (3/4)	37 (38)+39=76	25, 65	22, 87; 24, 10
K.144, G major (Albero?)	Cantabile (2/2)	18+16=34	12, 28 [10]	11, 21; 9, 89
K.170, C major	Andante moderato e cantabile (2/2), Allegro (3/8)	46 (And. mod. e cant.) + 99 (Alleg.)=192	Not bi-partite (And. mod. e cant.); 85 [39], 117[71] (Alleg.)	n/a (And. mod. e cant.) 24, 10; 72, 31 (Alleg.)
K.176, D minor	Cantabile andante, Allegrissimo (alternating 2/2 and 3/8)	20 (Cant.)+50 (Alleg.)+37 (Cant.)+85 (Alleg.)=192	(Cant.) 11 (Alleg.) 37[17] (Cant.) 89[19] (Alleg.) 124[17]	12, 36 (Cant.); 10, 51 (Alleg.); 22, 87 (Cant.); 52, 53 (Alleg.)

Table 1 (cont.)

Sonata	*Tempo (meter)*	*Length: A+B (in bars)*	*Crux: A, B (bar nos.)*	*GS (A, B); Crux (A, B)*
K.208, A major	Adagio e cantabile (4/4)	14+11=25	11-12, 22-23[8-9] overlap	8, 65; 6, 80
K.277, D major	Cantabile andantino (2/2)	23+17=40	20, 36[13]	14, 21; 10, 51
K.304, G major	Andante cantabile (2/2)	25(26)+26=51	16, 40(41)	15, 26; 16, 07
K.308, C major	Cantabile (2/2)	35+29=64	21, 50[15]	21, 63; 17, 92
K.347, G minor	Moderato e cantabile (2/2)	27+20=47	20, 38[11]	16, 69; 12, 36
K.474, E*b* major	Andante e cantabile (3/4)	28+26=54	12, 32	17, 30; 16, 07
K.478, D major	Andante e cantabile (3/4)	61+54=115	28, 71	37, 70; 33, 37
K.481, F minor	Andante e cantabile (2/2)	35+31=66	26, 57[22]	21, 63; 19, 16
K.485, C major	Andante e cantabile (2/2)	30+25=55	25, 49	18, 54; 15, 45
K.490, D major	Cantabile (2/2)	48+45=93	25, 70	29, 64; 27, 81
K.507, E*b* major	Andante e cantabile (2/4)	72(73)+58= 130(131)	41, 99	44, 50; 35, 85
K.534, D major	Cantabile (4/4)	19+16=35	10, 26[7]	11, 74; 9, 89
K.536, A major	Cantabile (2/2)	35+30=65	16, 48	21, 63; 18, 54
K.544, B*b* major	Cantabile (3/4)	22+19=41	12, 31[9]	13, 60; 11, 74
K.546, G minor	Cantabile (3/8)	54+54=108	29, 81	33, 37; 33, 37

IMPLICATIONS

Similarities and differences result. What is striking is that in both *E* and *C*, regardless of tempo, close direct correspondence (DC) GS-crux proportions result (21% *E* and 20% *C*; a total of 10 of 49 sonatas, or 20%). Summing DC and close correspondence (CC) in *E,* without duplicating sonatas, the GS-crux relationship is more than half or 55% (K. 1, 2, 3, 4, 8, 9, 10, 11, 14, 16, 18, 20, 22, 25, 26, 28; 16 of 29 sonatas). If indirect correspondence (IC) is added, then GS-crux rises to 69% (20 of 29 sonatas). The same procedure in *C* with no IC present yields 65% in 13 distinct sonatas (K. 77, 132, 144, 170, 176, 208, 288, 304, 308, 347, 481, 534, 544; 13 of 20 sonatas) The total for *E* and *C* based on DC plus CC is 59% (29 of 49 sonatas) and based on DC plus CC plus IC is 67% (33 of 49 sonatas). While *C* may be freer and improvisatory, these

Table 2. Summary.

Sonatas	*Direct correspondence (DC)*	*Close correspondence (CC)*	*Inverted correspondence (IC)*
Essercizi (n =29)	21% (6 sonatas): K. 2, 4, 9, 16, 18, 20	48% (14 sonatas), 34% (10 sonatas): K. 1, 2, 3, 4, 8, 10, 11, 14, 16, 18, 22, 25, 26, 28	14% (4 sonatas): K. 5, 15, 24, 29
Cantabile (n = 20)	20% (4 sonatas): K. 77, 144, 304, 308	50% (10 sonatas), 45% (9 sonatas): K. 132, 170, 176, 208, 277, 308, 347, 481, 534, 544	0% (0 sonatas)

Key. Red: overlapping sonatas; blue: calculation without duplication. (See full color version at www.performancescience.org.)

sonatas tend to show more frequent GS intersection in both halves than *E*. No GS-crux relationship in total sonata length was found. Rare, symmetrical sonatas are inconclusive (K. 3, 11, 12, 77, 546). The fact that K. 144, perhaps attributed to Albero, has GS in both halves could make authorship questionable or could show similar techniques.

From this initial study of less than 10% of Scarlatti's keyboard works, it seems that Scarlatti's proportional sense is strongly aligned to GS-crux placement, consciously or not. I propose to make a further, systematic GS-crux calculation of the remaining 500+ sonatas. Thus, new light may be shed upon the dubious chronology of the sonatas and their stylistic treatment, including Scarlatti's fervour for implied polymetric usage, 3-bar phrases in triple meter, the mixing of cultural elements, as well as other aspects, in these wonderful and complex musical offerings.

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References

Benton R. (1952). Form in the sonatas of Domenico Scarlatti. *The Music Review*, *13*, pp. 264-273.

Clark J. (1976). Domenico Scarlatti and Spanish folk music: A performer's re-appraisal. *Early Music*, *4*, pp. 19-21.

Doderer G. (1991). *Libro di Tocate per Cembalo: Domenico Scarlatti* (preface to facsimilie edition, pp. 7-52). Lisbon: Instituto Nacional de Investigação Científica.

Fadini E. (1978-1995). *Domenico Scarlatti. Sonatas per Gravicembalo* (vols. 1-8). Milan: Ricordi.

Halton R. (2002). Domenico Scarlatti and his Cantabile sonatas. *Musicology Australia*, *xxv*, pp. 22-48.

Harper N. L. (2002). The Iberian elements in the Scarlatti sonatas. *Piano Journal*, *Spring (67)*, pp. 15-22.

Harper N. L. (2005). Domenico Scarlatti's internal rhythm: The performer's challenge. *Piano Journal*, *Summer (77)*, pp. 16-18.

Howat R. (1986). *Debussy in proportion*. Cambridge: Cambridge University Press.

Kirkpatrick R. (1953a). *Domenico Scarlatti*. Princeton, New Jersey, USA: Princeton University Press.

Kirkpatrick R. (1953b). *Scarlatti: Sixty Sonatas in Two Volumes*. New York: Schirmer.

Longo A. (1906-1908). *Opere Complete per Clavicembalo di Domencio Scarlatti* (vols. 1-11). Milan: Ricordi.

Murchie G. (1978). *Seven Mysteries of Life*. New York: Houghton Mifflin.

Pestelli G. (1967). *Le Sonate di Domenico Scarlatti: Proposta di un Ordinamento Cronologico*. Turin: Giappichelli.

Puyana R. (1987). Influencias ibéricas y aspectos por investigar en la obra para clave de Domenico Scarlatti. *España en la Música de Occidente, 2*, pp. 51-59.

Sheveloff J. (1985). Domenico Scarlatti: Tercentenary frustrations (part I). *The Musical Quarterly*, *71*, pp. 399-436.

Sheveloff J. (1986). Domenico Scarlatti: Tercentenary frustrations (part II). *The Musical Quarterly*, *72*, pp. 90-118.

Sutcliffe W. D. (2003). *The Keyboard Sonatas of Domenico Scarlatti and Eighteenth Century Musical Style*. Cambridge: Cambridge University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Making sense out of taste: A study on listeners' preferences of performed tonal music

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Prior investigation by the author shows Lerdahl's concepts of tension and attraction to be an efficient tool for understanding performed expressive deviations. This paper reports a follow-up perceptual investigation of that study in which listener's preferences are examined in the light of the performance expressive strategies previously identified. University students were asked to rate on a seven-point scale the coherence, control of timing, control of dynamics, expressivity, tension, fluency, and global evaluation of recorded interpretations of Beethoven's Op. 53 (nine initial measures of the second movement) in which the existence or not of significant correlations between timing and dynamics as well the existence or not of significant correlations between expressive deviations and music structure had been identified in prior research. Results show that interpretations in which such correlations occur are rated systematically higher than interpretations in which such correlations are not the case.

Keywords: attraction; dynamics; musical preferences; tension; timing

Available research shows Lerdahl's (2001) concepts of tension and attraction developed in Tonal Pitch Space (TPS) to be an efficient tool for understanding perceived tension and attraction (Smith and Cuddy 2003) as well as performed expressive deviations (timing and dynamics) in tonal music (Martingo 2005, 2006, *in press*). In fact, when conducting a study on 23 commercially available recorded interpretations by world-class pianists of the nine initial measures of the second movement of Beethoven's *Waldstein* sonata (Op. 53), it was found that average dynamics correlated significantly to attraction values assigned by Lerdahl's model (Martingo *in press*). When considered individually, a panoply of expressive strategies emerged so that in 15 out of the 23 recordings analyzed, either timing or dynamics (or both, at times) correlated to attraction or tension values (or both, at times) as predicted by Lerdahl's model (Martingo *in press*). From that study, Lerdahl's theory of tension and attraction appears to be an important instrument for understanding performed expressive deviations, especially at the local level, where structural boundaries and expressive models fail to explain satisfactorily performer's expressive irregularities (e.g. Windsor and Clarke 1997, Repp 1992a). The research now reported consists of a perceptual analysis of the expressive strategies identified in that study. In particular, listeners' preferences were investigated according to the existence or not of significant correlations between expressive deviations (timing and/or dynamics) and music structure (represented by Lerdahl's concepts of tension and attraction), which forms Experiment 1, and according to the existence or not of significant correlations between timing and dynamics, which forms Experiment 2.

METHOD

Participants

Experiment 1

For this experiment, 67 university music students participated. On average, the participants were 25 years old, had 11 years of aural training, and 10 years of instrument training. Regarding sex, 33% of the sample consisted of women and 67% of men.

Experiment 2

This experiment involved 60 university music student-participants. On average, they were 24 years old, had 10 years of aural training, and 9 years of instrument training. Regarding sex, 33% of the sample were women and 67% were men.

Materials

Experiment 1

A set of six recordings of the initial nine measures of Beethoven's Waldstein Sonata (second movement). Two presented a correlation between dynamics and tension and/or attraction (Kempff, Deutshe Grammophon DG 429306-2, Recording B; and Barenboïm, EMI C25762863-2, Recording F). Two presented a correlation between timing and tension and/or attraction: Guilels (Deutshe Grammophon DG 419162-2, Recording D) and Gieseking (Philips

456790-2, Recording E). Finally, two presented no significant correlations between expressive deviations and tension: Solomon (EMI Testament SBT1190, Recording A) and Genov (Chamber CH-CD 106, Recording C).

Experiment 2

A set of three recordings of the same musical fragment were used: one presenting a significant positive correlation between timing and dynamics (Tipo, EMI 74788625 PM518, Recording A), one presenting no significant correlation between timing and dynamics (Genov, Chamber CH-CD 106, Recording B), and one presenting a negative significant correlation between timing and dynamics (Horowitz, Sony 518802-2, Recording C).

Procedure

Subjects were briefly informed of the purpose of the experiment, asked to listen sequentially to each of the interpretations of the musical fragment, and were then provided with an answer sheet and asked to successively listen and rate on a seven-point scale (1=minimum, 7=maximum) each one of the interpretations according to seven parameters: coherence, control of timing, control of dynamics, expressivity, tension, fluency, and global evaluation. Data analysis was carried out using Factor Analysis.

RESULTS

Exploratory Factor Analysis was applied to the data using the Principal Components method to reduce the original parameters (seven criteria per recording) into factors. Factor Analysis was found to be of an excellent applicability to the data, according to kmo (>0.87 and <0.91 in Experiment 1; >0.88 and <0.92 in Experiment 2) and *Bartlett* test of sphericity ($p<0.05$ in both studies). In fact, the data suggests that for each recording the best solution results from the extraction of one factor only (eigenvalues >1 and significant loadings >0.5). The total percentage of variance explained by each one of the factors extracted in each recording was good (>70%, <75% in Experiment 1; >66%, <76% in Experiment 2). Internal consistency/reliability of each extracted factor was tested using Cronbach Alpha and proved to be excellent ($\alpha>0.90$ in both studies: >0.92, <0.95 in Experiment 1; >0.91, <0.95 in Experiment 2). Once verified, the internal consistency of each factor and index for each recording was arrived at corresponding to the arithmetic average (unweighted) of the scores for each recording (between 1 and 7).

Table 1. Experiment 1: Descriptive statistics and Wilcoxon tests. For each index (recording), average values exhibiting the same superscript letter are not significantly different, according to Wilcoxon test (p<0.05).

Recordings	*N*	*Mean (±SD)*	*Mode*	*Min.*	*Max.*
Recording B*	67	4.78 (±1.10)[a]	5.0	1.3	7.0
Recording E**	67	4.61 (±1.12)[a,b]	4.3	1.7	6.6
Recording F*	67	4.38 (±1.30)[b,c]	3.9	2.1	7.0
Recording D**	67	4.32 (±1.25)[c]	5.0	1.3	7.0
Recording C***	67	4.25 (±1.22)[c]	4.9	2.0	6.7
Recording A***	67	4.19 (±1.09)[c]	3.7	2.0	6.9

Key. *Recording exhibiting a significant correlation between dynamics and structural factors (attraction and/or tension). **Recording exhibiting a significant between timing and structural factors (attraction and/or tension). ***Recording exhibiting no significant correlation between expressive deviations and structural factors.

Table 2. Experiment 2: Descriptive statistics and Wilcoxon tests. For each index (recording), average values exhibiting the same superscript letter are not significantly different, according to Wilcoxon test (p<0.05).

Recordings	*N*	*Mean (±SD)*	*Mode*	*Min.*	*Max.*
Recording A*	60	4.7 (±1.1)[a]	5.7	2.1	6.9
Recording C**	60	4.5 (±1.0)[a]	3.7	2.3	6.4
Recording B***	60	4.1 (±0.9)[b]	3.3	2.3	6.1

Key. *Recording exhibiting a positive significant correlation between timing (duration) and dynamics (a *crescendo* is accompanied by a *ritardando*). **Recording exhibiting a negative significant correlation between timing (duration) and dynamics (a *crescendo* is accompanied by an *accelerando*). ***Recording exhibiting no significant correlation between timing (duration) and dynamics.

Regarding Experiment 1, in which listener's preferences were investigated based on the existence or not of a correlation between expressive deviations and music structure, it was found that the recordings in which either timing or dynamics correlated at a significant level to structural factors (recordings B, E, F, and D) presented higher values than recordings exhibiting no correlation between expressive deviations and music structure (recordings A and C). In particular, recording B presented values significantly higher (p<0.05) than recordings F, D, C, and A, and recording E presented values significantly higher (p<0.05) than recordings D, C, and A. The recordings in which there was no correlation between expressive elements and music structure (recordings C and A) presented values which, although lower than all the others, were not significantly lower than recordings F and D (Table 1).

Regarding Experiment 2, which focused listener's preferences based on the existence or not of correlations between expressive deviations (timing and dynamics), it was found that the recordings in which timing correlated to dynamics (either positively as in recording A or negatively as in recording C) presented significantly higher values ($p<0.05$) than the recording in which no correlation between expressive deviations existed (Recording B) (Table 2).

DISCUSSION

From the factorial analysis of data, it becomes apparent that participants do not discriminate among factors but rather rate the parameters of each recording according to a global assessment. Regarding listener's preferences, results indicate that higher ratings are assigned to recordings in which expressive deviations correlate to music structure—as represented by Lerdahl's concepts of tension and attraction (Experiment 1), as well as to interpretations in which expressive factors correlate to each other (Experiment 2)—than to recordings in which no such correlations exist. This would indicate that the systematization of expressive deviations as well as their relation to music structure constitutes a rationale for listener's preferences. However, it remains to be ascertained whether the same results would be obtained from a larger sample of participants and materials. Regarding Experiment 1, further investigation is needed to determine whether the lower ratings of interpretations exhibiting no significant correlation turn out at a significant level, as well as to determine additional factors explaining differentiated ratings of interpretations in which such correlations occur. Regarding Experiment 2, the clear-cut significantly lower rating of the recording in which timing does not correlate to dynamics is in need of further investigation in order to rule out the hypothesis of other characteristics of the recording being responsible for the result arrived at. Notwithstanding, results are consistent with prior investigation showing music structure to be of primary importance in the shaping of musical interpretations and listener's expectations (Repp 1992b) as well as with studies showing the operationality of Lerdahl's theory as a cognitive framework and research tool (Smith and Cuddy 2003). In sum, the research now reported is expected to contribute to an understanding of taste and musical preferences as a structured and rationally determined phenomenon.

Acknowledgments

This research was carried out with the financial support of the FCT (Fundação para a Ciência e a Tecnologia) and FSE (Fundo Social Europeu, SFRH/BPD/14503/2003).

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References

Lerdahl F. (2001). *Tonal Pitch Space*. Oxford: Oxford University Press.

Martingo A. (2005). Testing Lerdahl's tonal pitch space: Evidence from music recordings. In J. Davidson, G. Mota, and N. Jordan (eds.), *Performance Matters: Abstracts from the International Conference on Psychological, Philosophical, and Educational Issues in Music Performance* (pp. 27-28). Porto, Portugal: Cipem.

Martingo A. (2006). Testing Lerdahl's tonal space theory: Performed expressive deviations and listener's preferences. *Proceedings of the 9th International Conference on Music Perception and Cognition* (pp. 560-561). Bologna, Italy: University of Bologna.

Martingo A. (in press). Testing Lerdahl's tonal space theory: Evidence from music recordings. *Musicae Scientiae*.

Repp B. (1992a). Diversity and communality in music performance: an analysis of timing microstructure in Schumann's *Träumerei*. *Journal of the Acoustical Society of America*, *92*, pp. 2546-2568.

Repp B. (1992b). Probing the cognitive representation of musical time: Structural constraints on the perception of timing perturbations. *Cognition*, *44*, pp. 241-281.

Smith N. and Cuddy L. (2003). Perceptions of musical dimensions in Beethoven's Waldstein sonata: An application of tonal pitch space theory, *Musicae Scientiae*, *7*, pp. 7-34.

Windsor W. and Clarke E. (1997). Expressive timing and dynamics in real and artificial musical performances: Using an algorithm as an analytical tool. *Music Perception*, *15*, pp. 127-15.

Thematic session: Performance practice

International Symposium on Performance Science
ISBN 978-90-9022484-8

How singers influence the understanding of sung text

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Singers differ from other instrumental performers in that they generally combine words with music, as song. Diction is an important aspect of vocal pedagogy, since the singer's foremost responsibility is perhaps to communicate the text and its meaning to the listener, whatever the language being sung. This study investigated the factors that are perceived to affect this communication process. We surveyed 143 singers, singing teachers, and listeners to choral and vocal music, asking them to list those factors they felt affected text intelligibility. In all, 43 factors were identified, of which 15 related to the performer (i.e. 33% of all statements made). These included those factors under the performers' control, such as diction, technique and training, stage presence, and breathing and phrasing. Singing teachers made more performer-related statements than other respondents, and the more important respondents deemed it to be able to understand the text in a familiar language, the more performer-related factors they listed. Thus, the performer is seen to influence sung text intelligibility in a number of ways. Knowing more about these factors can inform vocal pedagogy, particularly diction, technique, and communication with the audience. Future research will investigate some of these factors in a more objective, controlled way.

Keywords: singing; sung text; intelligibility; understanding; performer

Singing is ubiquitous in human society, and it is unique among music performance as being the only form to combine music with language. Much has been written on music's similarities to and differences from language (e.g. Meyer 1956, Sloboda 2005), but communicating sung text is clearly much more similar to language communication than mere musical expressivity.

One of the potential goals of song communication is for listeners to gain some level of understanding of the message being communicated. In a language with which the listener is familiar, this involves understanding the individual words, and therefore, the intelligibility of those words is of paramount importance. Even in a language with which the listener is unfamiliar, grasping the text can add to the overall meaning and understanding of the song. However, it is not necessarily the case that all listeners want to understand the text being sung. It might, for instance, depend on genre (pop song vs. opera vs. folk song) or the purpose of the music listening (background relaxation vs. attending to a concert).

From the singer's point of view, communicating text is only one aspect of performance, but it is arguably one of the most important. Singing training encompasses many technical aspects, including both vocal technique and diction, with the emphasis on the latter being on developing clarity of diction (Adams 1998, Falkner 1983). Clear diction obviously leads to more understandable words, and hence a better all-round performance, all other things—such as intonation, for example—being equal.

When considering how listeners understand spoken text, it is important to take into account characteristics not just of the speaker but also those of the listener, such as familiarity with the language and interest in the topic being communicated. Additionally, there may be other external factors affecting spoken text intelligibility, such as the level of background noise. We can assume that, in general, these broad classes of factor (speaker/performer, listener, environment) apply to the understanding of sung text also, as well as factors specifically related to the music and the setting of the words. Thus, there is more than just diction involved.

Very little research has been carried out investigating performer-related factors affecting sung text intelligibility, other than the work of Johan Sundberg and colleagues (e.g. Sundberg 1987) on isolated vowel intelligibility as a function of pitch. They demonstrated that at higher pitches, particularly in the soprano register, sung vowels become increasingly difficult to distinguish from one another, and this has been explained in terms of the relationship between the formant frequencies of the vowels and the resonant frequencies of the vocal tract. However, there is considerably more to understanding text, whether sung or spoken, than identifying individual vowels out of context.

This paper reports selected findings from a survey designed to address a variety of questions related to the understanding of sung text. Musicians (mainly singers and singing teachers) were asked what they perceive to be the most important factors in determining the intelligibility of sung text. The survey was intended to produce a fairly representative list of factors and allow for some quantitative analysis in terms of the relative importance of those factors. It also allowed us to investigate the importance of different factors as a function of respondents' expertise as performers and teachers, and the importance that they ascribe to being able to understand the sung text. Although a wide range of possible factors underlying intelligibility were described, this paper focuses on those factors related to the performer.

The aims of the study, then, were to determine how important text intelligibility is, in both familiar and unfamiliar languages, to a population of singers, singing teachers, and other musicians, and to formulate a list of factors affecting text intelligibility, together with some indication of their relative importance. The data were collected through the use of a questionnaire.

METHOD

Participants

There were 143 respondents, 61% female and 39% male, aged between 18 and 67 (mean=35.8, SD=13.7 years). They comprised 47% experts (professional musicians, semi-professional singers, and student singers) and 53% non-experts (amateur singers and non-singers). Eighteen of them were or had been singing teachers. Half the respondents spent at least 75% of their music listening time listening to vocal and choral music.

Materials

We piloted and conducted a questionnaire survey based loosely on that of Himonides and Welch (2006) to address the broad research questions outlined above. The questionnaire was made available both on the web (through SurveyMonkey) and on paper.

Procedure

Likely groups of respondents, such as choirs and singing teachers, were invited to complete the survey, and it was publicized on the PsyMus email distribution list (see www.sempre.org.uk). In addition to collecting demographic data, including listening preferences and singing experience, the questionnaire asked respondents how important it was to them to be able to understand sung text, in both familiar and unfamiliar languages, and what proportion of music listened to was vocal and/or choral. Respondents were then asked to list the factors (as responses to open-ended questions) that they believe underlie the intelligibility of sung text, under five headings: performer-related, listener-related, environment-related, music- and words-related, and other. One example for each of the first four headings was given. In this paper, only those responses categorized as being performer-related will be discussed.

RESULTS

The intelligibility of sung text in familiar languages was very important to 61% of respondents but very important to only 17% when text is in an unfamiliar language.

In all, 394 open-ended statements were provided by 94 respondents. These were categorized by the authors independently and, after discussion over any categorization differences, 43 factors were identified. All statements that respondents put under the "other" heading were re-categorized into the first four categories, and some statements belonged in multiple categories. There were 15 performer-related factors representing 33% of all statements. These factors are listed in Table 1, with the most often mentioned first.

Table 1. The number of statements (No.) and cumulative per cent (Cum. %) of performance-related factors affecting sung text intelligibility.

Factor	*No.*	*Cum. %*
Articulation, diction, enunciation	73	21
Balance between singer(s) and accompaniment	58	39
Communication of text, expression, and stage presence	38	50
Attitude, effort, preparation, projection	31	59
Volume	20	65
Language/text: Feel for/knowledge of/understanding	19	70
Voice quality and range	17	75
Choral ensemble	14	79
Consonants	13	83
Technique and training	13	87
Pronunciation and accent	11	90
Vowels	10	93
Other	9	96
Performance style, vibrato	8	98
Breathing and phrasing	6	100

The respondents were then split into subgroups on the basis of various demographic variables, including level of expertise (expert vs. non-expert), perceived importance of text understanding (very important vs. quite or not important), and the proportion of vocal/choral music listened to (at least 75% vs. less than 75%). Additionally, singing teachers were considered separately.

Singing teachers (n=18) made more performer-related statements than other respondents. There was also a significant correlation between the number of performer-related factors provided by respondents and their rating of the importance of text intelligibility in a familiar language ($p<0.04$): those who felt that understanding text sung in a familiar language was more important provided more factors related to the performer. There were no other significant findings involving performer-related factors.

DISCUSSION

The survey yielded a rich source of data, both qualitative and quantitative. The respondents, 18 of whom were singing teachers, had a broad range of singing expertise and are, therefore, a good representative sample of vocal performers. It was felt important to tap singing teachers' views as they are responsible for training singers in aspects of vocal technique including diction.

Overall, a third of the statements provided by respondents were related to the performer. In particular, singing teachers provided more performer-related statements than other respondents. This is probably due to the fact that they would be more focused on improving the performers' delivery and clarity as part of their teaching. Similarly, those respondents who rated understanding text in a familiar language as more important tended to provide more performer-related factors than those who did not. Most respondents were themselves performers, so they would have been aware of the impact that they as performers could have on listeners' understanding. If respondents were not very interested in being able to understand the text, we would perhaps expect fewer performer-related factors to occur to them.

The four most regularly mentioned factors accounted for almost 60% of the performer-related statements. These related to diction and articulation (which was one of four example factors give on the questionnaire), balance between singer(s) and accompanying instruments, communication and stage presence, and attitude, preparation, and projection. With the exception perhaps of balance, these factors are all clearly under the control of the performer and, therefore, addressed by vocal pedagogy.

It would be interesting to repeat this study with a population who listen to vocal and/or choral music but are not themselves singers or instrumental musicians. Although it is unlikely they would come up with any new factors not identified in this survey, it is quite possible that different factors would be seen as more important

Finally, it should be noted that this exploratory study identifies only those factors that respondents believe are important. Future research will investigate the potential impact of some of the factors nominated in an objective fashion. This will enable us to increase our understanding of how to enhance the intelligibility of sung text and improve singers' diction through more effective vocal pedagogy.

Acknowledgments

Thanks to Gunter Kreutz for assistance in setting up the SurveyMonkey online survey and invaluable suggestions at the design and analysis stages of the study.

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References

Adams D. (1998). *A Handbook of Diction for Singers: Italian, German, French*. Oxford: Oxford University Press.

Falkner K. (1994) *Voice*. London: Kahn & Averill.

Himonides E. and Welch G. (2006). A large-scale survey regarding listeners' tastes to sung performances. Paper presented at the 9th *International Conference on Music Perception and Cognition*, Bologna, Italy.

Meyer L. B. (1956). *Emotion and Meaning in Music*. Chicago: University of Chicago Press.

Sloboda J. A. (2005). *Exploring the Musical Mind: Cognition, Emotion, Ability, Function*. Oxford: Oxford University Press.

Sundberg J. (1987). *The Science of the Singing Voice*. DeKalb, Illinois, USA: Northern Illinois University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Effects of musical texture, performer's preparation, interpretative goals, and musical competence on error patterns in organ performance

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This study compared the influence of musical texture (homophony versus contrapuntal writing), conditions of preparation (sight-reading versus prepared), interpretative goals, and level of competence (results in organ performance competitions) on the type and number of errors that are committed in organ performance. In the sight-reading condition, eight professional organists recorded different interpretations of two short Baroque organ pieces of contrasting texture. In the prepared condition, 16 organists made two recordings of J.S. Bach's organ fugue in D minor (BWV 538). Results show that musical texture has a strong effect on the type of errors: substitutions and intrusions tend to be more contextually appropriate when the musical setting is mostly homophonic than when it is contrapuntal. Interpretative goals also affect the distribution of errors: organists make fewer errors for the notes belonging to the voice that they are trying to emphasize. In addition, the error rate is higher for notes belonging to inner voices and is positively correlated with onset density. Finally, although musical competence had no significant effect on error rate in sight-reading conditions, the prize-winning performers made significantly fewer errors in the prepared condition.

Keywords: organ performance; performance errors; musical structure; interpretation; musical

The analysis of performance errors is a powerful tool that provides valuable data which can be used to build plausible models of the performer's mental representation of a musical score (Palmer and Van de Sande 1993, 1995; Repp

1996). Such an analysis allows us to study the effects of musical texture, interpretative goals, and musical competence on this representation. The present study sought to compare the influence of musical texture (homophony versus contrapuntal writing), conditions of preparation (sight-reading versus well-prepared piece), interpretation (emphasizing a given voice, mechanical versus expressive performance), and level of competence (as assessed by results in organ performance competitions) on the type and amount of errors that are committed in organ performance.

METHOD

Participants

All participants were professional organists from the Montreal area, or organ students at McGill University in Montreal. Table 1 summarizes the relevant information about the participants.

Materials

Three pieces were selected for this study. In the sight-reading condition, organists recorded a short French Baroque contrapuntal piece (*Premier Agnus* by Nicolas de Grigny) and a short German Baroque homophonic piece (a chorale harmonization of *Wachet auf, ruft uns die Stimme* by Samuel Scheidt). In the prepared condition, two recordings of the *Organ Fugue in D minor* BWV 538 (also known as the "Dorian" fugue) by J. S. Bach were made.

The performances were recorded on the Casavant organ of the Church of St-Andrew and St-Paul in Montreal, Canada. This five-manual organ (five keyboards and a pedal-board) was built in 1931. The console was restored in 2000, at which time a MIDI system was installed by Solid State Logic.

Procedure

In the sight-reading condition, the score was given to the organists 20 minutes before the recording session began, in order to give them time to practice on the organ. For the contrapuntal piece (*Premier Agnus*), three different interpretations were recorded. In one interpretation, the organists were told to emphasize the soprano part, in another, the alto part, and in a third one, the tenor part. Two recordings were made for each interpretation. The order of the instructions was randomized according to a Latin square design. For the homophonic piece (*Wachet auf*), two different interpretations were recorded. In one interpretation, the organists played the piece in an expressive way, while in the second they were asked to play a mechanical, or

Table 1. Information on participants**.** F=female; M=male. The age range is indicated in years in parentheses. Prize-winners refers to the number of organists who have won prizes at national or international competitions.

Piece	*Participants*	*Mean age*	*Prize-winners*
Wachet auf (sight, homophonic)	8 (2F, 6M)	27 (23-30)	3
Premier Angus (sight, contrapuntal)	8 (2F, 6M)	26 (19-30)	3
Dorian fugue (prepared)	16 (2F, 14 M)	37 (24-59)	9

expressionless, performance. For both interpretations, two recordings were made. Organists always played the expressive version first, and then the mechanical one. In the prepared condition (Dorian fugue), organists were given 20 minutes to practice, after which they made two recordings of the piece.

The audio signal was recorded through two omnidirectional Boehringer ECM 8000 microphones. The audio and MIDI signals were sent to a PC computer through a MOTU audio interface, recorded using Cakewalk's SONAR software, and stored on a hard disk. Using the MIDI data, performance notes were matched to score notes using an algorithm written in MATLAB by the first author.

RESULTS

Contextual effects on error rate

It has been observed that more attention is given to outer voices than to inner ones, both when listening (Huron 1989) and while performing (Palmer and Van de Sande 1993). This study corroborates earlier results: in all three pieces the error rate for a given score note was significantly higher for notes belonging to an inner voice than for notes belonging to an outer voice (Table 2).

One could also expect that, since notes belonging to a theme or important motive are presumably given more attention, both on the part of the performer and of the listener, the error rate for these notes would be lower than for non-motivic notes. This hypothesis was tested on the performances of the Dorian fugue, which was the only piece of substantial length under study here. Since this piece is a fugue, motives are present in all the voices; however, most motives occur in outer voices, presumably because the composer wants to make them stand out perceptually. The position of a note (inner/outer voice) was thus also taken into account in order to avoid any

Table 2. Comparison of error rates per score note in outer and inner voices**.** The total number of score notes belonging to each category is given in parentheses. The significance of the χ^2 value was assessed using a one-tailed Fisher exact test (* p<0.05, ** p<0.01, *** p<0.001). The frequency count (total number of notes analyzed for all performances of a given piece) is given in square brackets.

Piece	*Outer voices*	*Inner voices*	*χ^2 value (df=1)*
Wachet auf	1.46% (176)	3.61% (193)	54.36*** [11808]
Premier Agnus	1.16% (136)	1.49% (184)	3.07* [15360]
Dorian fugue	0.33% (1547)	1.01% (1154)	161.56*** [86432]

Table 3. Effect of musical texture on the contextual appropriateness of substitutions and intrusions**.** An error was defined as contextually appropriate if its pitch was equivalent (via octave transposition) to that of another score note belonging to the same chord. Percentages are given in parentheses.

Substitutions and intrusions	*Homophonic (Wachet auf)*	*Contrapuntal (Premier Agnus)*
Contextually appropriate	47 (34.3%)	16 (18.8%)
Contextually inappropriate	90 (65.7%)	69 (81.2%)

confounding effect. A maximum likelihood analysis of variance showed that both factors (outer/inner and motivic/non-motivic) had a significant impact on the error rate per score note [outer/inner: $\chi^2(1)=122.74$, $p<0.001$; motivic/non-motivic: $\chi^2(1)=12.49$, $p<0.001$], with no significant interaction.

Among the other factors affecting the error rate, it seems likely that the number of score notes played simultaneously (or *onset density*) would have an effect, with higher rates of error for score events correlated with a higher onset density. For all three pieces, the average error rate per score note was positively correlated with onset density, with correlations of 0.24 (df=143, p<0.01), 0.16 (df=146, p<0.05), and 0.08 (df=1382, p<0.01) for *Wachet auf, Premier Agnus,* and the Dorian fugue, respectively.

Palmer and Van de Sande (1993) had previously shown that musical texture has an effect on the type of errors committed in performance. In this study, we analyzed the effect of musical texture on two types of pitch errors, namely substitutions (replacing a score note by a note with the wrong pitch) and intrusions (playing additional notes not indicated in the score), by comparing the type of errors found in sight-reading performances of a mostly homophonic piece (Scheidt's *Wachet auf*) and a contrapuntal piece (Grigny's

Premier Agnus). These two pieces have approximately the same number of score notes (369 and 320, respectively), with a mostly four-voice texture throughout (average number of active voices per score event=3.98 for both pieces), thus providing an adequate basis for comparison. Table 3 shows that substitutions and intrusions tend to be more contextually appropriate when the musical setting is mostly homophonic and less contextually relevant in a contrapuntal setting [$\chi^2(1)=6.18$, $p<0.05$].

Interpretative goals and performer's intentions

This study also sought to examine whether the intentions of the performer affected the error rate. This was tested by comparing the mean error rate per score note for each voice in all three interpretations of the *Premier Agnus*, in which performers were instructed to emphasize the soprano, alto, or tenor part. Results show that the interpretative goal affects the distribution of errors: although the overall mean error rate does not vary significantly, organists make fewer errors for the notes belonging to the voice that they are trying to emphasize (Figure 1). A repeated-measures analysis of variance on the mean error rate, with instruction and voice as within-subject factors, showed no significant effect of instruction or voice, but a significant interaction between instruction and voice on the error rate [$F(6,42)=2.36$, $p<0.05$, Huynh-Feldt epsilon=1.05].

Musical competence

Repeated-measures analyses of variance were conducted on the total number of errors per performance with musical competence (prize-winner or non-

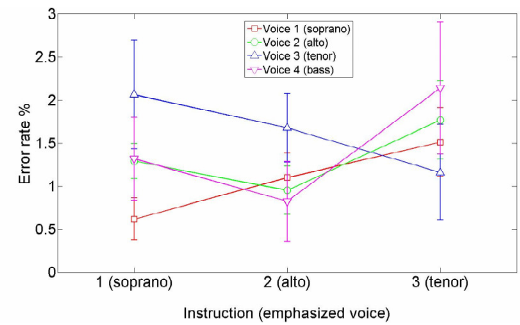

Figure 1. Effect of interpretative goals on error rate. Mean error rate for all voice combinations, averaged across performers. Error bars represent standard errors of the mean. (See full color version at www.performancescience.org.)

prize winner) as a between-subjects factor, for all three pieces. Although musical competence had no significant effect on error rate in sight-reading conditions [$F(1,6)=0.43$, $p>0.5$ for *Wachet auf*; $F(1,6)=0.54$, $p>0.1$ for *Premier Agnus*], the prize-winners made significantly fewer errors in the prepared condition [$F(1,14)=5.43$, $p<0.05$ for the Dorian fugue].

DISCUSSION

The pattern of performance errors is affected by both local musical context and global musical texture, suggesting that musical structure modulates the mental representation of the score at several levels. The effect of the interpretative goal on the pattern of performance errors implies that performers pay more attention to the voice they are emphasizing.

Acknowledgments

This research was supported by a fellowship from the Social Sciences and Humanities Research Council of Canada to the first author and an NSERC grant to the second author. The authors wish to thank Julien Boissinot, Darryl Cameron, Bennett Smith, and the musical authorities of the Church of St-Andrew and St-Paul (Montreal).

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References

Huron D. (1989). Voice denumerability in polyphonic music of homogeneous timbres. *Music Perception*, *6*, pp. 361-382.

Palmer C. and Van de Sande C. (1993). Units of knowledge in music performance. *Journal of Experimental Psychology, 19,* pp. 457-470.

Palmer C. and Van de Sande C. (1995). Range of planning in music performance. *Journal of Experimental Psychology, 21,* pp. 947-962.

Repp B. H. (1996). The art of inaccuracy: Why pianists' error are difficult to hear. *Music Perception*, *14,* pp. 161-184.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Cognitive feedback and metaphors in emotional communication instruction of musical performance

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The use of metaphorical language is a common strategy in music teaching. Nevertheless, there is a lack of scientific knowledge about this subject. Inspired by earlier studies on cognitive feedback, emotion, and performance, an experiment was designed in order to test the metaphorical impact in the improvement of musical emotional communication. Two kinds of language were set: (1) technical, used in cognitive feedback studies, and (2) metaphorical. These were separately applied to two groups of violin students through a cognitive feedback process in order to make them communicate a specific emotion. Their performances were recorded and submitted to acoustical analysis as well as being evaluated by a set of judges. Results indicated that after only one session both languages improved students' performance and their emotional communication skills. Demonstrating that metaphors are efficient tools to learn musical expressivity, this study contributes to the research of metaphorical language use in a musical context and also to the knowledge about traditional teaching processes to enhance emotional communication.

Keywords: performance; metaphors; emotion; cognitive feedback; musical pedagogy

The use of metaphors for music-teaching purposes is well known by music educators, who have employed them for many years. As we may see in Barten (1992, 1998) and Woody (2002), music teachers apply them to evoke images and feelings that promote technical and expressive enhancement.

Barten (1998) says that this enigmatic way of communicating musical concepts seems to have a main role in supporting motor-affective aspects, actions, and tendencies, and gives the impression of being especially prepared to communicate aesthetic experiences. The problem with this kind of language is that ambiguity and complexity appears to hinder the comprehensiveness and the study of the phenomenon.

On the other hand, Kövecses (2002) defends that, in a cognitive linguistics point of view, metaphors are able to fulfill with significance something that is uncertain or difficult to understand.

Casey (1991) asserts that there are several expressions that instrumental teachers' use that are metaphorical expressions. The multidimensional potential of this sort of language is obvious, since educators apply it in different contexts.

According to Juslin and Laukka (2000), Juslin (2001), and Juslin *et al.* (2004), metaphors usually are closely connected to the enhancement of emotional communication. According to these researchers, teachers use them as expressive cues to improve students' communication of emotions. Juslin and Laukka (2000) argue that cognitive feedback that uses technical expressions is a much more effective way to increase emotion communication.

However, it is our belief that metaphorical language can be used in an objective way and can be as efficient as technical terminology in the communication of emotions. The aim of this study is to find out if metaphors can improve emotional communication when used through cognitive feedback. The objective is to provide experimental evidence that cognitive feedback based on metaphors can impact students' performances in a very precise way, making them communicate a specific emotion.

METHOD

Participants

For this study, 16 violin students (eight female and eight male, aged 15 to 18 years old) who had been studying for at least five years in a specialized music school in the north of Portugal played the role of performers. The role of judges was played by 126 students (86 female and 40 male, aged 12 to35 years old) who had been studying in specialized and regular schools.

Materials

Figure 1 presents the melody used in the musical instruction session. Recordings of the students' performances were made using Sound Forge 5.0 software with a high quality Sony-ECM-MS907 microphone, placed 1.5 m

Figure 1. The melody used in the study.

from the player's position and Logitech X-230–2.1 loudspeakers. Acoustic analysis was made using the software Peak Pro XT5–5.02, Praat-6.6.02, and Audio Leak 1.1.1. The perception of emotions was assessed using written questionnaires in order to collect and select metaphorical expressions currently used by teachers.

Procedure

An exploratory study was made in order to obtain metaphorical expressions commonly used by instrument teachers in order to improve their students' communication of *happiness*. With this aim they were instructed to provide metaphors that correspond with technical terminology used for the same purpose reported by Juslin (2001). Afterwards, violin students were divided into two groups of eight. One was instructed with technical language and the other with the metaphorical expressions previously collected. Each student attended a single 30-minute lesson in which those language strategies were applied through cognitive feedback.

An ecological approach was adopted to provide this cognitive feedback. During the teaching lessons the investigator recorded the students' performances. Through the use of computer software, he showed acoustical parameters and gave cognitive cues to the students (technical ones to the subjects of one group, metaphorical ones to the subjects of the other group). Recordings were made at the beginning and at the end of each session. These pre- and post-test recordings were analyzed acoustically to determine if students improved their skills in playing the necessary acoustic codes to communicate the intended emotion.

In order to determine if they improved emotional communication, the recordings were evaluated by a set of judges through a questionnaire. The questionnaire inquired whether or not an emotion was expressed and, when affirmative, what kind of emotion it was (among sadness, anger, happiness, and tenderness) as well as its intensity.

RESULTS

Acoustic analysis evaluated mean tempo, mean sound level, frequency spectrum, mean articulation, articulation variability, and timing deviations. According to earlier studies on performance emotional communication (see Juslin 1997, Juslin and Laukka 2000), these are relevant indicators to understand the musical code in usage. *T*-tests were performed to find differences in the acoustical parameters between pre- and post-test within each group. As shown in Table 1, there is an increase of mean tempo, frequency spectrum, mean sound level, and a decrease of articulation variability, mean articulation, and timing deviations. With the exception of articulation variability, they confirmed the direction of expected indicators. Differences between the two groups were determined using *t*-tests. There were no significant differences with the exception of mean sound level post-test (p=0.02).

Judges' evaluations were submitted to Pareto's analyses. Table 2 reports the proportion of emotions that were detected by judges on pre- and post-test recordings. Differences between both groups were statistically significant, except for the case of sadness post-test. Results showed that happiness was better detected. According to these data, technical language was more efficient for the detection of this emotion. Nevertheless, this difference was already present on pre-test recordings. McNemar tests were carried out in order to verify if there were differences between pre- and post-test on happiness. Significant differences were found for the group that was submitted to technical language, $X^2(1)=152.98$, $p<0.05$, and for the group that was submitted to metaphorical language, $X^2(1)=222.88$, $p<0.05$.

Table 1. T values (df=7) for differences between pre- and post-test in both groups.

	Technical language group		*Metaphorical language group*	
	t (7)	*p* value	*t* (7)	*p* value
Mean tempo	-8.03	0.000	-5.17	0.001
Frequency spectrum	-4.59	0.003	-3.03	0.019
Mean sound level	-4.70	0.002	-4.35	0.003
Mean articulation	3.72	0.007	5.77	0.001
Articulation variability	1.92	0.096	2.84	0.025
Timing deviations	1.46	0.189	6.00	0.001

Table 2. Proportion of detected emotions in pre- and post-test on both groups.

Emotion	*Technical language*	*Metaphorical language*
Pre-test		
Happiness	11.89%	6.44%
Tenderness	17.80%	22.31%
Sadness	15.78%	18.87%
Anger	4.10%	2.36%
Post-test		
Happiness	28.27%	24.73%
Tenderness	7.59%	5.80%
Sadness	3.02%	3.57%
Anger	11.55%	15.93%

DISCUSSION

Acoustical analysis and judges' evaluations demonstrated that the communication of happiness through musical performance may be improved in a single lesson. This improvement can be obtained through the use of either technical or metaphorical language in musical instruction based on ecological cognitive feedback.

As much as technical language, metaphorical language seems to have the capacity to make students aware of the acoustic code needed to modify their performances in a certain way. Since there were similar improvements in musical performance with both groups, we infer that metaphors provide analogous cognitive effects to technical language. Hence, improvement of emotional communication would be one of the roles of musical teaching.

A limitation of this study is the age of the performers, since metaphorical language may assume different impacts depending on the subjects' maturity. Future research must develop experiments that study the influence of metaphors on teaching according to a participants' age. Further studies should increase the number of instruction sessions and also consider other emotions and other musical instruments. Also, this study does not clarify what would happen if the students were asked to demonstrate happiness in their performance and then let them practice for 30 mins without instruction.

Certainly, brain monitoring could be a powerful tool in order to verify the cerebral network that is activated when a metaphorical instruction is given.

This study indicates that metaphorical language can be efficiently used when teaching communication of an emotion. We believe this is just a part of their potential. One possible reason why metaphors have been used in music education for so long with success is because they relate to something that is much less clear than a specific emotion. The subjectivity of a metaphor can activate a palette of emotions, and that can be richer than the basic ones.

Acknowledgments

Thanks are due to Christopher M. Johnson from the University of Kansas (USA), Ana Braga and Lino Costa from the University of Minho (Portugal), and José Alexandre Reis from ARTAVE (Professional Artistic Music School of Ave Valley, Portugal).

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References

Barten S. S. (1992). The language of musical instruction. *Journal of Aesthetic Education, 26*, pp. 53-61.

Barten S. S. (1998). Speaking of music: The use of motor-affective metaphors in music instruction. *Journal of Aesthetic Education, 32*, pp.69-97.

Casey J. L. (1991). *Teaching Techniques and Insights for Instrumental Music Educators*. Chicago: GIA Publications.

Juslin P. N. (1997). Perceived emotional expression in synthesized performance of a short melody: Capturing the listener's judgment policy. *Musicae Scientiae, 1*, pp. 225-256.

Juslin P. N. (2001). Communicating emotion in music performance: A review and theoretical framework. In P. N. Juslin and J. A. Sloboda (eds.), *Music and Emotion: Theory and Research* (pp.310-337). Oxford: Oxford University Press.

Juslin P. N., Friberg A., Schoonderwaldt E., and Karlsson J. (2004). Feedback learning of musical expressivity , In A. Williamon (ed.), *Musical Excellence* (pp. 247-270). Oxford: Oxford University Press.

Juslin P. N. and Laukka P. (2000). Improving emotional communication in music performance through cognitive feedback. *Musicae Scientiae, 4*, pp. 151-183.

Kövecses Z. (2002). *Metaphor: A Practical Introduction*. Oxford: Oxford University Press.

Woody R. H. (2002). Emotion imagery and metaphor in the acquisition of musical performance skill. *Music Education Research*, *4,* pp. 213-224.

Friday
23 November 2007

Keynote paper

International Symposium on Performance Science
ISBN 978-90-9022484-8

Enhancing music and dance performance with EEG-neurofeedback

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We have demonstrated professionally significant enhancements in music and dance performance through EEG-neurofeedback training, where participants learn to control selected brain rhythms through a real time biofeedback process. In our laboratory, other "peak performance" applications in healthy subjects have included attention, memory, and microsurgical skills. These results are reviewed, and new controlled studies are outlined. Earlier results with Royal College of Music students have been extended to novice singing abilities, first in Trinity College of Music instrumentalists, and second in Goldsmiths adult education blues and gospel singers. Slow wave and fast wave EEG training protocols were compared for effects on established song and instrumental repertoire and on improvisation. A study of dance performance is outlined, extending an earlier study with university competitive Latin and ballroom dancers to first year students at the Laban dance conservatoire. EEG slow wave training and heart rate variability coherence training, both successful with ballroom dancers, were compared with kinesthetic instruction. Aside from music and dance, performance outcome measures include cognitive assessment, including creativity and mood and personality.

Keywords: music; dance; EEG; neurofeedback; creativity

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Thematic session: Musicians’ health

International Symposium on Performance Science
ISBN 978-90-9022484-8

Orofacial considerations concerning musicians

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Orthodontic problems, soft tissue trauma, focal dystonia, denture retention, herpes labialis, dry mouth, and temporomandibular joint (TMJ) disorders were identified as orofacial problems of career musicians. The most prevalent problems affecting wind players involve overuse of muscles resulting from repetitive movements of playing, especially because it requires increased ventilation and increased orofacial muscle activity. Therefore, we have developed the Lip Pressure Appliance (LPA). It consists of a lip protector made in one piece, which has been manufactured from a relatively flexible thermoplastic material and configured and fitted to the lower dental arch of the player who uses it. In addition to this, many patients who are doing orthodontic treatment face difficulties when playing because of the pressure against the orthodontic brackets. We have developed therefore yet another protector, the Orthodontics Lip Pressure Appliance (OLPA). The movement of the teeth during the orthodontic treatment has been predicted and with different combinations of materials it was possible to leave a space for the teeth movement without loosing retention of the OLPA. This way people who have doubts about orthodontic treatment because of their musical career have the problem solved.

Keywords: wind instruments; orofacial problems; Lip Pressure Appliance (LPA); Orthodontics Lip Pressure Appliance (OLPA); orthodontic treatment

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International Symposium on Performance Science
ISBN 978-90-9022484-8

Joint hypermobility is a liability for the performing artist

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Joint hypermobility is defined as a range of joint movement that is considered excessive, taking into consideration the age, gender, and ethnic background of the individual, being greater in women and in those of Asian origin compared with other ethnic groups. All newborn babies can be considered to be hypermobile, but the range of movement diminishes progressively during childhood and then more gradually during adult life. Elderly hypermobile people haved retain many facets of their hypermobility throughout life. Originally perceived to be a feature of rare inherited diseases such as Marfan and Ehlers-Danlos syndromes, it was only in the in the 1960s that hypermobility syndrome was seen to exist apart from these diseases and as an entity in its own right. In the early 1970s it was first linked to ballet dancers. There is now evidence that it represents a risk factor for injury in performing artists in general.

Keywords: joints; hypermobility; performance; injury; prevention

Joint mobility, though susceptible to training, is largely determined by genetic influences. Joint hypermobility is defined as an excessive range of joint movement taking into consideration age, gender, and ethnic background. It underpins and facilitates the performance of a range of activities including dance, music, gymnastics, acrobatics, contortionism, and yoga. There is evidence that hypermobility acts as a positive selection factor for entry into ballet school in both boys and girls (Grahame and Jenkins 1972, McCormack *et al.* 2004) and proves an asset for instrumentalists over their non-hypermobile peers (Grahame 1993).

The biological cost to be paid for this enhanced performance is the occurrence of the Joint Hypermobility Syndrome (JHS). JHS is now seen as a non-life threatening genetic disorder, which renders connective tissues—

ligaments, muscles, tendons, bones, skin—fragile, more susceptible to injury, and more vulnerable to its effects. Healing may be delayed and protracted. This poses a distinct threat that may jeopardise a performer's career. The JHS phenotype (JHSP) has been characterized and classified according to validated criteria, termed the 1998 Brighton criteria, which provides a useful tool for identifying those at risk (Grahame *et al.* 2000). The aim of this study was to establish the prevalence of the JHSP among performing artists, who present with musculoskeletal ailments.

METHOD

Participants

As part of their routine assessment, all patients seeking advice at a British Association for Performing Arts Medicine (BAPAM) musculoskeletal clinic between 2000 and 2003 were tested for compliance with the Brighton Criteria for the JHSP.

Materials

Joint hypermobility is determined by the application of the 9-point Beighton scoring system (Beighton *et al.* 1973), which requires the observer to establish whether actively or passively the subject is able to perform the movements as listed in Table 1.

Procedure

The Brighton Criteria for JHS incorporates the Beighton 9-point scoring system for hypermobility but takes into account a variety of frequently-encountered symptoms as well as phenotypic features. They comprise two major and eight minor criteria:

Major criteria

1. A Beighton score of 4/9 or greater (either currently or historically).
2. Arthralgia for longer than 3 months in 4 or more joints.

Minor criteria

1. A Beighton score of 1,2, or 3/9 (0, 1, 2, or 3 if aged 50+).
2. Arthralgia (≥3 months) in one to three joints or back pain (≥3 months), spondylosis or spondylolysis/spondylolisthesis.

Table 1. Movements used to determine joint hypermobility. One point may be gained for each side for the first four manoeuvres so that the hypermobility score will have a maximum of nine points if all are positive. In individual subjects the score diminishes with aging.

	Right	*Left*
Passively dorsiflex the fifth metacarpophalangeal joint to $\geq$90°	1	1
Oppose the thumb to the volar aspect of the ipsilateral forearm	1	1
Hyperextend the elbow to $\geq$10°	1	1
Hyperextend the knee to $\geq$10°	1	1
Place hands flat on the floor without bending the knees	1	
Maximum Total	9	

3. Dislocation/subluxation in more than one joint, or in one joint on more than one occasion.
4. Soft tissue rheumatism $\geq$3 lesions (e.g. epicondylitis, tenosynovitis, bursitis).
5. Marfanoid habitus (tall, slim, span/height ratio >1.03, upper:lower segment ratio less than 0.89, arachnodactily [+ve Steinberg/wrist signs].
6. Abnormal skin: striae, hyperextensibility, thin skin, papyraceous scarring.
7. Eye signs: drooping eyelids or myopia or antimongoloid slant.
8. Varicose veins or hernia or uterine/rectal prolapse.

The JHS is diagnosed in the presence of two major criteria, one major and two minor criteria, or four minor criteria. Where there is an unequivocally affected first-degree relative, two minor criteria will suffice. JHS is excluded by the presence of Marfan or Ehlers-Danlos syndromes (other than the EDS Hypermobility type; formerly EDS III) as defined by the Ghent (De Paepe *et al.* 1996) and the Villefranche (Beighton *et al.* 1998) criteria respectively. Criteria major 1 and minor 1 are mutually exclusive as are major 2 and minor 2. The Brighton Criteria have yet to be validated for use in children under 16 years of age.

RESULTS

The results highlighted an expectedly high prevalence of JHS among performers, particularly among dancers and musicians. The JHSP was identified in 56 (70%) out of 80 dancers and in 54 (40%) of 134 musicians. Among the musicians the prevalence was highest in pianists (45%), string players (40%), and woodwind players (35%) and lowest in the brass (25%)

and percussion players (20%). Among the string players, the phenotype was seen to the greatest extent in violin and cello players (50% each) and least in guitarists (25%) and double-base players (18%), with viola players and harpists falling in the middle range (35% each). Analyzing the musicians' presenting diagnosis according to whether or not they showed the JHSP, the occurrence of JHSP was highest in those presenting with overuse injury and joint/spinal pain (both 55%), and lowest in those who had soft tissue lesions (35%) and osteoarthritis (25%).

DISCUSSION

A strong case can be made for identifying those artists who manifest the JHSP. They are the ones who are at greater risk of injury, both of the acute and overuse varieties. They need appropriate advice and guidance on how best to protect themselves from potentially disastrous consequences. There is a parallel need to bring the occurrence and significance of hypermobility to the attention of teachers, dance companies, and orchestras.

Acknowledgments

I am grateful to the BAPAM Trustees and Medical Committee for allowing me to perform this study. Ethical Committee approval was granted by the Brent Medical Ethics Committee (REC reference number: 04/Q0408/52).

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References

Beighton P., De Paepe A., Steinmann, B., *et al.* (1998). Ehlers-danlos syndromes: Revised nosology, Villefranche, 1997. *American Journal of Medical Genetics*, *77*, pp. 31-37.

Beighton P. H., Solomon L., and Soskolne C. L. (1973). Articular mobility in an African population. *Annals of the Rheumatic Diseases, 32*, pp. 413-417.

De Paepe A., Devereux R. B., Deitz H. C., *et al.* (1996). Revised diagnostic criteria for the Marfan syndrome. *American Journal of Medical Genetics*, *62*, pp. 417-426.

Grahame R. (1993). Joint hypermobility and the performing musician. *New England Journal of Medicine, 329*, pp. 1120-1121.

Grahame R., Bird H. A., Child A. *et al*. (2000). The revised (Brighton 1998) criteria for the diagnosis of benign joint hypermobility syndrome (BJHS). Journal of Rheumatology, 27, pp. 1777-1779.

Grahame R. and Jenkins J. M. (1972). Joint hypermobility—asset or liability? A study of joint mobility in ballet dancers. *Annals of the Rheumatic Diseases, 31*, pp. 109-111.

McCormack M., Briggs J., Hakim A. J. (2004). A study of joint laxity and the impact of the Benign Joint Hypermobility Syndrome in student and professional ballet dancers. *Journal of Rheumatology. 31*, pp. 173-178.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The role of retraining in rehabilitation from focal dystonia

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Focal dystonia is a debilitating movement disorder which occurs as a result of many repetitions of a specific task and typically manifests in involuntary muscle contractions. In pianists, an incoordination occurs between fingers, making it impossible to play at concert level. Three pianists with focal hand dystonia participated in a retraining program based on a biomechanically sound way of playing with minimal tension. Quality of scales and repertoire were assessed before and after pianism retraining by several rating systems and included assessment by a listener blinded as to which hand was dystonic and whether they were assessing playing pre- or post-retraining. Scale quality improved with retraining in all three pianists, with improvement in both hands, but greater in the dystonic hand. While there was no change in the blinded listener being able to identify the non-dystonic hand from pre-training to post-training, they could correctly identify the dystonic hand 79% pre-retraining, but this decreased to 28% post-retraining. The test repertoire evaluation and the visual evaluation rating were shown to improve significantly by 1.0 and 1.3 points, respectively (on a five point rating scale), from pre-training to post-training.

Keywords: focal dystonia; piano technique; retraining; biomechanical

Focal dystonia is usually painless and most commonly affects only one hand, often involving involuntary flexion of just two or three specific fingers. The incidence may be as high as one in 200 professional musicians (Altenmüller 2000, Schuele *et al.* 2005). In focal dystonia, the areas in the brain responsible for the movement of adjacent fingers have become enlarged, due to overuse, and can overlap (Elbert 1998). Treatments options have included administration of trihexyphenidyl or botulinum toxin, splinting, and limb immobilisation, but only exceptionally do musicians with focal dystonia return to normal motor control (Altenmüller and Jabusch 2007). Different methods of retraining alone without the above medical interventions have reported anecdotal success, but few have been accessed scientifically. The aim of this research was to determine whether a specific pianism retraining program would result in improvement in symptoms of focal dystonia.

METHOD

Participants

Three pianists with focal dystonia participated in a specific retraining program based on a biomechanically sound way of playing with minimal tension.

Procedure

Prior to retraining, each subject recorded three separated scales and an arpeggio with each hand alone in the same octave at a range of tempi. They also recorded segments of repertoire that were challenging because of the dystonia. Daily retraining then began for a minimum of ten sessions within two weeks, after which time the scales and repertoire excerpts were re-recorded. Recorded excerpts were assessed by a professional pianist ("blinded listener"), blinded to the identity of the subject, who was asked to determine which hand was playing and whether the playing was pre- or post-retraining. The sound only of different scales was assessed using a Scale Quality Evaluation (SQE) and a Dystonic Hand Identification Evaluation (DHIE), where the listener was asked to identify whether the hand playing was dystonic or not. During the retraining the technique of each pianist was analyzed and broken down into the smallest possible units. Posture at the instrument was corrected with particular attention to the sitting position and the height of the piano stool, and head, neck, shoulders, back, arms, wrist, and hands were freed to move with minimum tension. The retraining program began by teaching each pianist to play single notes at a very slow tempo, beginning with the non-dystonic hand and only when perfected progressing to the dystonic hand. Each finger was required to move from a supported metacarpophalangeal (MCP) joint with the weight of the arm transferred to the key without unnecessary interference from the wrist or forearm. Each finger was aligned with the key before lifting and playing,

Table 1. Subject characteristics.

	Subject 1	*Subject 2*	*Subject 3*
Age in years	53	23	23
Sex	M	F	M
Level of performance	International soloist	Graduate student	Doctoral student
Years of playing	43	13.5	16
Duration of dystonia	5 years	4 years	8 months
Hand dominance	Right	Right	Right
Hand affected	Right	Right	Left
Digits affected	D3 and D4	D2and D3	D2

meaning that the hand position was adjusting with each finger. Independent movement was not necessary as pianism rarely requires fingers to move in isolation. When single notes were accomplished with ease, consecutive notes were attempted at a very slow tempo, first at the interval of a major second before progressing to chromatic intervals and major and minor thirds. Transferring the weight across larger intervals was assisted by a downward convex movement of the wrist. It was important to take the weight on each finger before turning, lifting, and playing the following note. Each finger was deliberately released after playing and the dystonic finger actively released away from the compensatory finger. When cramping occurred, an unrelated thought was found to help the completion of the movement. Wrist and forearm relaxation was monitored on both the radial and ulna sides. In order to incorporate the retraining into repertoire, groups of notes were processed as a single thought, enabling increased speed.

RESULTS

The subject characteristics on initial assessment are presented in Table 1. An analysis of variance (ANOVA) of all five variables (subject, retraining, scale, tempo, and dystonic hand) showed that the variables that have a significant effect on the SQE are retraining [$F(1, 137)=73.8$, $p<0.0001$], dystonia [$F(1, 137)=27.04$, $p<0.0001$], and the interaction between these two variables [$F(1, 137)=7.71$, $p<0.0001$], the latter signifying a greater improvement in one hand than the other after retraining. Average scores in the non-dystonic hand improved from 3.12 to 3.78, an increase of 0.66 points, while in the dystonic hand scores improved from 2.32 to 3.54, an increase of 1.22 points (see Figure 1). Thus, the improvement in the dystonic hand was twice that of the non-dystonic hand. In terms of the DHIE score, the blinded listener correctly

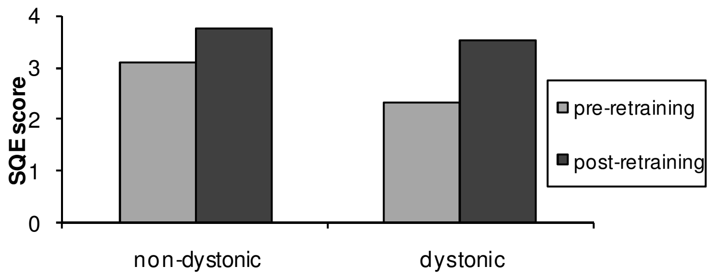

Figure 1. Changes in Scale Quality Evaluation with retraining for both dystonic and non-dystonic hands.

identified the non-dystonic hand in 41 of 55 times pre-training (75%) and 54 of 62 times post-training (87%); this change was not statistically significant. However, with the dystonic hand, the blinded listener correctly identified the dystonic hand 44 of 56 times (79%) but post-training could only correctly identify the dystonic hand 18 of 64 times (28%), a significant decrease [$\chi^2=30.44$, $p<0.0001$]. Analysis for the test repertoire (TRE) found an overall increase in scores from pre- to post-training of 1.0 point [$F(1,131)=67.13$, $p<0.0001$]; however, there was also a significant interaction between time and subject [$F(2,131)=16.32$, $p<0.0001$]. This showed increases in TRE of 1.3 and 1.9 points for two of the subjects respectively, but a decrease of 0.1 points for the other subject. Similarly, the visual evaluation rating (VER) showed an overall increase from pre- to post-training of 1.3 points [$F(1,131)=79.21$, $p<0.0001$]. However, again there was a significant interaction between time and subject, with two subjects showing increases pre- to post-training of 1.4 and 2.3 points respectively, while the third subject showed an increase of 0.3 points [$F(2, 131)=12.80$, $p<0.0001$].

DISCUSSION

The most important finding of this research is that focal dystonia can be successfully treated through retraining in pianism. Both scale playing and repertoire excerpts improved in all three subjects. Various factors emerged as crucial in the retraining process. The initial daily contact was of vital importance to the sufferers, not only because it aided the motivation but also because increments of improvement were subtle and needed to be built upon with painstaking patience by both researcher and sufferer. This intensive period was thought responsible for the retraining method producing quicker results than those reported in the literature. Jabusch and Altenmüller (2006) reported that most responders in their study averaged treatment between two and three years, while in this study the concert pianist who had not been able to play for five years was able to return to a full time career after one year and both other subjects are now playing at concert level.

It was important to retrain the whole technique, not just the affected fingers. Retraining began with the non-injured hand and fingers only, progressing to the injured fingers once the movements were completely free of unnecessary tension.

Although postural correction was included as part of the method, the retraining protocol began with sound, as evaluating this musical element helped the pianist to monitor his/her own sense of postural balance and to differentiate between tension and release. The sound is at its best only when the body moves in the most biomechanically ideal way. Whereas many pianists believe in playing from the key, it was found that the lifting of the finger when done from the MCP joint was a freeing movement which counteracted the cramping dystonic tendency. It was important for each finger to take the weight of the arm and to release immediately after playing before turning by a rotary convex swing from the wrist to align the next finger with the key. Curling of the fingers was avoided, as was lifting in isolation. Awareness of complete lack of tension on both the radial and ulnar side of the wrist and elbow was established, and the arm hung freely from the shoulders so that the ensuing sound was round and full.

A second important finding of our research is that the scale playing of the dystonic hand improved to a level greater than the level of the non-dystonic hand prior to retraining (see Figure 1). The implication of this finding is that the overall pianism of each subject was improved by the retraining. Possible mechanisms for the improvement in pianism with retraining include: establishing a balanced posture, refining the movement patterns so that the fingers were aligned with the keys, removing the tension in the wrist and forearm, maintaining freedom of movement in the elbow and shoulder, enabling the fingers to carry the weight of the arm, and releasing each note immediately after playing.

Although focal dystonia is a neurological disease, we believe that what happens at the muscular level is of crucial importance in the development of this condition. The fact that it is possible for most musicians to engage in hours of practice at an instrument without problems of this kind means that repetition per se is not the cause. This suggests that the cortical alterations seen in focal dystonia may be associated not just with overuse but also with misuse. If a return to the instrument involves the same stressful movement patterns as before, injury will recur regardless of what interim treatment is applied. In the case of focal dystonia, because the stress of the previous movement patterns has caused the enlargement of finger representations in the cortex, we believe that the only possible way to lasting recovery is to create "new connections" by retraining the technique.

Acknowledgments

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References

Altenmüller E. (2000). From Laetoli to Carnegie: Evolution of brain and hands as prerequisites of music performance in the light of music physiology and neurobiology. Paper presented at the *10th Symposium of the International Study Group of the Archaeology of Music,* Kloster Michaelstein, Germany.

Altenmüller E. and Jabusch H. C. (2007). Focal dystonia in musicians: Recent results and new developments. Paper presented at *Medical Problems of Musicians and Dancers*, Aspen, Colorado, USA.

de Lisle R., Speedy D. B., Thompson J., and Maurice D. G. (2006). Effects of pianism retraining on three pianists with focal dystonia. *Medical Problems of Performing Artists, 21*, pp. 105-111.

Elbert T. (1998). Alteration of digital representations in somatosensory cortex in focal hand dystonia. *NeuroReport, 9*, pp. 3571-3575.

Jabusch H. C., Zschucke D., Schmidt A., *et al.* (2005). Focal dystonia in musicians: Treatment strategies and long-term outcome in 144 patients. *Movement Disorders, 20,* pp. 1623-1626.

Jabusch H. C. and Altenmüller E. (2006). Focal dystonia in musicians: From phenomenology to therapy. *Advances in Cognitive Psychology, 2,* pp. 207-220.

Schuele S., Jabusch H. C., Lederman R. J., and Altenmüller E. (2005). Botulinum toxin injections in the treatment of musician's dystonia. *Neurology, 64,* pp. 341-343.

Thematic session: Psychology of performance

International Symposium on Performance Science
ISBN 978-90-9022484-8

Theoretical and practical applications of mental imagery

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Mental imagery is used extensively by musicians as well as by athletes in sport. As performers, musicians and athletes strive to achieve excellence. Preparation is an essential precursor to performance and the use of mental imagery is a common method of achieving this state. In the sport psychology literature an applied model of imagery use has been proposed, the model suggests that the sport situation (i.e. training, competing, rehabilitation) will dictate the function of imagery used (e.g. arousal regulation, skill rehearsal), and this in turn will impact the outcome (e.g. feelings of efficacy, technique). Relevant mental imagery research in sport and music is reviewed, making links across the disciplines in an attempt to inform research and practice. The applied model of imagery use in sport guides the development of a similar applied model of imagery use in music.

Keywords: mental imagery; sport; music performance; applied model; interdisciplinary

The purpose of the present paper is to review the relevant mental imagery research in sport and music, making links across the disciplines in an attempt to inform research and practice. A secondary purpose is to employ the applied model of imagery use in sport as a guide for developing a similar applied model of imagery use in music.

Mental imagery is any experience that mimics sensory or perceptual experiences, whereby the individual is consciously aware of his/her imagery experience; thus, it differs from daydreams (Richardson 1969). Imagery can incorporate all five physical sensations (i.e. vision, audition, olfaction, gustation, and kinesthetic; Vines 1988). Previous experience is not necessary to create an image; as a result, it is possible to imagine future events or a specific, desired outcome. Paivio (1985) identified the functional roles through which imagery influences sport performance, and his framework has been the predominant guide for imagery research in the sport psychology literature. The framework indicates that imagery affects performance through both cognitive and motivational functions. The cognitive function includes strategy and specific skill rehearsal whereas the motivational function consists of being successful, controlling emotions, and overcoming adversity.

Imagery has been demonstrated to be an effective means of enhancing performance in the performing arts and sport (e.g. dance, Fish *et al.* 2004; sport, Hall 2001; and music, Holmes 2005). However, simply using imagery is not sufficient to produce the desired effect on performance (Lee 1990, Smith *et al.* 2007). Martin *et al.* (1999) developed an applied model of imagery use in sport in an attempt to guide imagery practice and enhance the effectiveness of that practice. For the purposes of this paper, the model has been adapted for musicians as illustrated in Figure 1. The model indicates that the situation will dictate the function of imagery used, and this in turn will affect the outcome. For example, in a rehearsal setting where learning is the focus, the musician would likely use imagery for cognitive purposes and the outcome may be a technically correct performance of a scale. The model goes on to suggest that this relationship between imagery use and desired outcome is not perfect. With athletes several variables have been found to influence this relationship. Imagery ability, the quality of one's imagery, is one variable that influences this relationship. In the sport literature, athletes who have higher imagery ability use imagery more frequently than those with lower ability and derive greater benefits from that imagery use (Isaac 1992). Skill level is another variable that moderates the relationship between imagery use and desired outcome; athletes of higher skill levels use more imagery than those of lower skill levels (Gregg and Hall 2006). Type of sport has also been identified as a moderator of imagery use (Munroe *et al.* 1998). There is some evidence that the imagery use of musicians may also be explained by Martin *et al.*'s (1999) model and may be moderated by similar variables. University classical musicians who were performance majors reported using imagery more often to maintain focus, feel confident, and overcome difficulties than non-performance majors (Gregg *et al.* in press). The same study provided evidence that imagery use may also be moderated by type of instrument; the study found that of the participants the singers reported greater use of images of successful goal achievement as compared to the instrumental musicians.

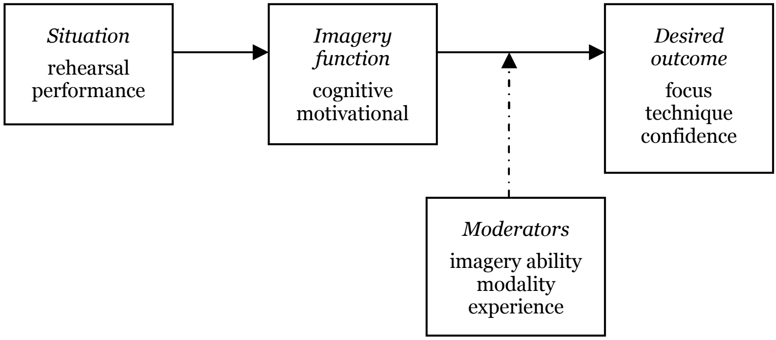

Figure 1. Applied model of imagery use. Adapted from Martin *et al.* (1999).

In sport, there is considerable support for the proposal that the function of imagery used should match the desired outcome. With respect to the cognitive function of imagery, numerous studies conducted in a wide variety of contexts have shown that the use of cognitive imagery is conducive to enhancing the learning and performance of motor skills (see Driskell *et al.* 1994 for a review). As well, the performance benefits of using cognitive imagery have been reported for strategy rehearsal in several sports (e.g. entire canoe slalom races; MacIntyre and Moran 1996). Similar evidence exists in the music literature, as Holmes (2005) identified auditory imagery as essential for learning and memorizing, suggesting a cognitive content to the imagery.

With respect to motivational imagery, when preparing for a performance, imagery of a desired performance goal aids musicians' preparation (Lehmann 1997). Using motivational imagery prior to an actual performance enhances confidence, critical to successful execution in both sport and music (Callow *et al.* 2001, McCormick and McPherson 2003, Schneiderman 1991).

Martin *et al.*'s (1999) applied model was developed to guide research and practice in sport imagery research. This version, adapted for musicians (Figure 1), may be suitable for guiding such inquiry as well. The applied model has led to the examination of questions such as where athletes use imagery, why they use it (i.e. cognitive or motivational), when they use it, and what they image (e.g. perspective, modality; Munroe *et al.* 2000). Using the model provides a structure for examining imagery use in music and allows for similar questions to be examined. In sport, there has been limited research into the modalities of imagery use; the focus has predominantly been on visual images with some examination of kinesthetic imagery. Though athletes are generally encouraged to use all their senses when creating an image there has been limited interest expressed by sport imagery researchers into the effects of other modalities including auditory imagery, spatial imagery, and so on. Generally, music imagery research has taken a more inclusive approach to imagery modality, and this may have important implications for application in sport psychology. Imagery modality may be another moderator of the imagery use and desired outcome relationship. Specific modalities may align better with explicit imagery functions leading to desired outcomes. This certainly warrants further exploration.

The effectiveness of imagery interventions may be improved through a structured approach to imagery use. Smith and his colleagues (2007) demonstrated the effectiveness of enhancing athletes' performance through a structured imagery intervention. Simply asking athletes or musicians to engage in imagery is not enough. Imagery is a skill (Rodgers *et al.* 1991), it can be practiced, and improvements may be made over time, resulting in enhanced effectiveness of the imagery. Thus, by encouraging musicians to practice imagery and teaching them when and what to image at appropriate times, their imagery may become more effective, and ideally they will experience the corresponding benefits of the effective use of imagery.

MAIN CONTRIBUTION

This paper fosters the sharing of information across disciplines which may impact the use of imagery by both musicians and athletes. A model of imagery use in music could guide music imagery research and help practitioners employ imagery in an appropriate and effective manner in applied settings

IMPLICATIONS

The development of a suitable model for imagery use in music will help to guide research and practice, resulting in performers' using imagery more effectively.

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References

Callow N., Hardy L., and Hall C. (2001). The effect of a motivational general-mastery imagery intervention on the sport confidence of high-level badminton players. *Research Quarterly for Exercise and Sport, 72,* pp. 389-400.

Driskell J. E., Copper C., and Moran A. (1994). Does mental practice enhance performance? *Journal of Applied Psychology, 79,* pp. 481-492.

Fish L., Hall C., and Cumming J. (2004). Investigating the use of imagery by elite ballet dancers. *Avante, 10,* pp. 26-39.

Gregg M., Clark T., and Hall, C. (in press). Seeing the sound: An exploration of the use of mental imagery by classical musicians. *Musicae Scientiae*.

Gregg M. and Hall C. (2006). The relationship of skill level and age to the use of imagery by golfers. *Journal of Applied Sport Psychology, 18,* pp. 363-375.

Hall C. (2001). Imagery in sport and exercise. In R. N. Singer, H. A. Hausenblas, and C. M. Janelle (eds.), *Handbook of Sport Psychology* (2nd ed., pp. 529-549). New York: John Wiley & Sons.

Holmes P. (2005). Imagination in practice: A study of the integrated roles of interpretation, imagery and technique in the learning and memorization processes of two experienced solo performers. *British Journal of Music Education, 22,* pp. 217-235.

Isaac, A. R. (1992). Mental practice: Does it work in the field? *The Sport Psychologist, 6,* pp. 192-198.

Lee C. (1990). Psyching up for a muscular endurance task: Effects of image content on performance and mood state. *Journal of Sport and Exercise Psychology, 12,* pp. 66-73.

Lehmann, A. (1997). Acquired mental representation in music performance: Anecdotal and preliminary empirical evidence. In H. Jørgensen and A. Lehmann (eds.), *Does Practice Make Perfect?* (pp. 141-164). Oslo: Norwegian Academy of Music.

MacIntyre R. and Moran A. (1996). Imagery use among canoeists: A worldwide survey of novice, intermediate, and elite slalomists. *Journal of Applied Sport Psychology, 8,* p. S132.

Martin K., Moritz S., and Hall C. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist, 13*, pp. 245-268.

McCormick J. and McPherson G. (2003). The role of self-efficacy in a musical performance examination: An exploratory structural equation analysis. *Psychology of Music, 31,* pp. 37-51.

Munroe K. J., Giacobbi P. R., Hall C., and Weinberg R. (2000). The four Ws of imagery use: Where, when, why and what. *The S*port *Psychologist, 14,* pp. 119-137.

Munroe K., Hall C., Simms S., and Weinberg R. (1998). The influence of type of sport and time of season on athletes' use of imagery. *The Sport Psychologist, 12,* pp. 440-449.

Paivio A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Science, 9***,** pp. 241-253.

Richardson A. (1969). *Mental Imagery*. New York: Springer.

Schneiderman B. (1991). *Confident Musical Performance.* St. Louis, Missouri, USA: MMB Music.

Smith D., Wright C., Allsopp A., and Westhead H. (2007). It's all in the mind: PETTLEP-based imagery and sports performance. *Journal of Applied Sport Psychology, 19,* pp. 80-92.

Vines S. W. (1988). The therapeutics of guided imagery. *Holistic Nursing Practice, 2*, pp. 34-44.

International Symposium on Performance Science
ISBN 978-90-9022484-8

What does mental imagery mean to university music students and their professors?

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The *Investigating Musical Performance* research project was devised to explore how musicians develop their learning about performance in undergraduate, postgraduate, and wider community contexts. Analysis of questionnaire data from 264 respondents revealed that mental rehearsal was the least popular aspect of musical learning, but verbal data from case study interviews showed that student musicians used musical imagery in various ways and ascribed many meanings to the term. This paper, through a short, specially devised questionnaire, explores how undergraduate musicians at the University of York and their professors use musical imagery. Many reported using it for specific musical activities such as practice, composition, performance, and thinking music in the mind for pleasure, although it was not necessarily a developed skill. Because the benefits are significant, it is proposed that imagery work should become a more formal part of musical training rather than a peripheral part of musical experience.

Keywords: musical imagery; learning; students; professors

Musical imagery has been defined as "our mental capacity for imagining sound in the absence of a directly audible sound source" (Godøy and Jørgensen 2001). The experience may be manifest in multiple ways, including deliberate use (to rehearse musical ideas, to experience a musical work in one's mind, to analyze and imagine a new score, or to compose) and non-deliberate use, such as hearing music in the mind as an involuntary experience. Although musical imagery has considerable value for instrumental and vocal learning, it seems to be neglected in many learning methods. It is rare to find mention of either imagery or mental rehearsal in instrumental tuition books, yet many eminent performers have advocated its use, including the pianists Horowitz and Rubinstein and the violinist Fritz

Kreisler. Rubin-Rabson (1937) discovered that mental rehearsal aids the memorization of music and that using mental rehearsal as well as physical practice was more productive than physical practice alone. A study at the Royal College of Music (Connolly 2002) examined the use of mental skills to enhance the performance of twelve Royal College of Music (RCM) students and found benefits including improved memory and confidence, greater connection with the music, mind, and body, and increased productivity in practice. This small-scale survey aims to discover how students and staff are using various aspects of musical imagery and forms a pilot study for further work comparing larger groups and different musical genres.

METHOD

Participants

This survey focuses on third-year music students (n=11), their lecturers (n=10), and instrumental and vocal teachers (n=4) at the University of York. All the students were aged 18-21; the staff age groups were as follows: 25-34 (n=1); 35-44 (n=3); 45-54 (n=5); 55-64 (n=5).

Materials

Participants were asked to complete a short questionnaire exploring aspects of their musical background, their involvement in composing and conducting, what the term "mental musical imagery" meant to them, and whether it was a formal part of their musical development. They were also asked to rate their awareness of various aspects when imagining music and given the opportunity to add their own comments on their use of imagery.

Procedure

Data was received from third-year students, lecturers, and instrumental/ vocal teachers and was analyzed using SPSS and thematic analysis. Comparisons are made between the two main groups: third-year students and the staff (lecturers and instrumental/vocal teachers).

RESULTS

Respondents were asked to define what the term "musical mental imagery" meant to them by indicating their agreement (by ticking from a list) the statements shown in Table 1. Respondents were also asked to rate their awareness of elements when imagining music, as shown in Table 2.

Table 1. Definition of the term musical mental imagery.

	% staff agreeing	*% students agreeing*
Rehearsing music in your head	92.9	100.0
Rehearsing memorization of music	50.0	36.4
Rehearsing interpretative possibilities	57.1	54.5
Rehearsing physical movements in your mind	35.7	63.6
Visualizing a successful performance	42.9	81.8
Realizing your mind is playing its own soundtrack and you are not consciously controlling it	64.3	72.7

Table 2. Mean rating of awareness of elements when imagining music; ratings were made on a scale from 1-7, where 1="not at all aware" and 7="very aware."

	Staff	Students
Melody	6.50	6.64
Harmony	5.14	5.00
Articulation	5.64	5.18
Rhythm	6.29	6.18
Timbre	5.00	4.64
Texture	5.00	5.18
Acoustic	2.57	2.73
Intonation	4.71	4.36
Awareness of physical movements	4.36	4.27

Imagery use had been consciously developed by 69.2% of the staff and 45.5% of the students. Discussion of imagery with a teacher was recalled by 38.5% of the staff and 63.6% of the students. None of the students recalled references to imagery in tuition books for their instrument, although 23.1% of the staff could. When teaching, 42.9% of the staff (including all the instrumental/vocal teachers) and 27.3% of the students encouraged their pupils to use imagery.

Respondents were asked how often they used imagery (never, sometimes, or always) as a deliberate practice strategy and how often they would work on a new piece in their mind before beginning to play or sing it (Table 3).

Data was also examined to compare different groups: males/females, those with/without absolute pitch, instrumental teachers/non-teachers, composers/non-composers, and conductors/non-conductors. Results for the

Table 3. Use of imagery as a deliberate practice strategy and before playing a new piece.

	Deliberate practice strategy		*Before playing a new piece*	
	% staff	*% students*	*% staff*	*% students*
Never	15.4	9.1	23.1	27.3
Sometimes	53.8	81.8	69.2	63.6
Always	30.8	9.1	7.7	9.1

question defining musical imagery showed that the following groups had the highest agreement with each statement: (a) Rehearsing music in your head: 100% agreement from students, females, those with absolute pitch, non-composers, non-conductors, and instrumental teachers; (b) Rehearsing interpretative possibilities: 75% of those with absolute pitch and 75% of instrumental teachers agreed; (c) Rehearsing physical movements in your mind: 63% of students agreed; (d) Visualizing a successful performance, rehearsing memorization, and realizing your mind is playing its own soundtrack and you are not consciously controlling it: 100% of those with absolute pitch agreed. When the totals for all aspects were added, those with absolute pitch had the highest score: 475 of a possible 600. Instrumental teachers scored 450, students 409, composers 381.5, non-conductors 376.6, females 375, males 369.2, conductors 362.5, non-instrumental teachers 357, non-composers 355.5, those without absolute pitch 352.4, and staff 342.9.

When data for the question looking at the awareness of musical elements when imagining music was examined, the instrumental teachers had the highest total mean score across all elements (50 out of a possible 63), followed by those with absolute pitch (48.25), females (46.42), staff (45.21), non-conductors (44.88), composers (44.78), conductors (44.53), students (44.18), those without absolute pitch (44.10), non-instrumental teachers (43.51), non-composers (43.46), and males (43.08). The highest-scoring groups for both questions were the instrumental teachers and those with absolute pitch. Factors such as the age when an instrument was started, number of hours per week spent playing or listening to music, and high self-rating of aural skills did not have significance on the scores for the definition of musical imagery or for the awareness of elements when imagining music.

DISCUSSION

Musical imagery has multiple applications and each individual has a unique approach to their use of it, depending on factors including their background, training, personality, sensory preferences, and the musical task with which they are engaging. It would appear that those with absolute pitch and instrumental/vocal teachers have the highest use of imagery. Thematic analysis of qualitative data from the questionnaire allows a more detailed perspective on the use of imagery from this sample.

Imagery was found to be a useful practice tool, with the added benefits that memorization was quicker and more reliable and that it aided interpretation. The advantages of using mental rehearsal to avoid problems resulting from physical practice were mentioned by many, and it produced a better overall preparation for performance as it led to a greater understanding of musical aspects, such as harmonic and structural elements, and coordinating one part with another.

Instrumental and vocal teachers attached considerable value to imagery, using it to aid students in technical understanding, interpretation, and pre-performance consolidation, and students described examples of it in lessons they gave and received. Composers were particularly enthusiastic about imagery, and staff composers and conductors mentioned its importance to them in being able to assess scores. Conductors also mentioned its use in creating personal and individual musical interpretations. Further uses included manipulating visual and verbal imagery associated with music, feeling rhythms, thinking through a piece of music for fun, and using imagery to develop personal connection with the music. Many of the staff had consciously developed their musical imagery by imagining music and comparing it with a recording or with the passage played on a piano, whereas students took it for granted as a peripheral presence and felt it might develop inevitably with increased musical contact.

Staff comments on the importance of mental imagery/rehearsal as a tool in musical learning included: (a) holistic awareness of its overall importance, its creative and musical benefits; (b) its importance in healthy physical practice; and (c) its use in developing a wider musical understanding. Students recognized its value for: (a) awareness of the importance of the mind in performing and learning; (b) its use in consolidation of musical learning and the promotion of more advanced musical learning; and (c) awareness of the creative role it can play. Staff use it to a greater extent than students for composition, for general understanding of music, including memorization, and are more likely to have consciously developed their ability to use it. It could be suggested that in some cases, shorter playing hours could be compensated for by greater use of imagery. Students use imagery more than staff for practice, rehearsing physical movements, and for visualization of performance, presumably because they are more engaged with the process of learning an instrument.

Imagery has considerable benefits for all kinds of musical activities and is significant for the understanding of effective practice and performance. Further research could determine whether different types of musical training and the time spent playing or listening to music are important factors, and how we develop the ability to hear music in our heads. Although imagery use might develop inevitably through increased musical contact, musical skills could be further enhanced by a more conscious awareness and application of imagery, and should be a more deliberate part of musical teaching and learning.

Acknowledgments

Thanks to Chris Macklin, Dr Ioulia Papageorgi and Dr John Potter. This articles forms part of the *Investigating Musical Performance* research project, funded by the ESRC/TLRP (Award: RES-139-25-0101): Institute of Education (Graham Welch, Andrea Creech, Ioulia Papageorgi, Evangelos Himonides), Leeds College of Music (Tony Whyton, Christophe de Bezenac), Royal Scottish Academy of Music and Drama (Celia Duffy, Frances Morton), University of York (John Potter, Elizabeth Haddon).

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References

Connolly C. (2002). Mental skills to optimize musical performance. In C. Stevens, D. Burnham, G. McPherson *et al.* (eds.), *Proceedings of the 7th International Conference on Music Perception and Cognition* (pp. 97-100). Adelaide: Casual Productions.

Godøy R.I. and Jørgensen H. (2001). *Musical Imagery*. Lisse, The Netherlands: Swets and Zeitlinger.

Rubin-Rabson G. (1937). The influence of pre-analytic study in memorizing piano music. *Archives of Psychology, 31,* pp. 1-53.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Measuring self-efficacy in music

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For the musician, belief in one's abilities is of paramount importance to performance success. A fully comprehensive means of measuring musical self-efficacy, however, has yet to be devised and validated. This paper reports a pilot of three new instruments for measuring musical self-efficacy beliefs. Fifty-three tertiary music students completed three questionnaires pertaining to (1) *general* musical self-efficacy, as well as self-efficacy beliefs relating *specifically* to (2) musical learning and (3) performing. The questionnaires were shown to be robust, each achieving a high score for internal consistency. Summative scores were created casewise for each questionnaire, and correlations were found between self-efficacy scores and the self-regulated learning behavior "seek advice from peers, teachers, or others," as measured using a new self-regulated learning questionnaire. Students were significantly more self-efficacious for learning than for performing, and scored lower still on the general scale. Each of these measures correlated with students' self-rated abilities on a range of musical skills and attributes, including musicality, level of perseverance, and the ability to manage stage fright.

Keywords: self-efficacy; self-regulated learning; practice; performance; teaching

Between the conception of an idea, the acceptance of a challenge, and the achievement of a goal is a course of events greatly influenced by a person's beliefs. Although there are many psychological influences on people's actions and achievements, self-efficacy has been shown to have the greatest predictive power of attainment (Zimmerman *et al.* 1992). Self-efficacy encompasses a person's self-beliefs in their abilities to carry out criterial tasks to achieve outcomes (Bandura 1996). It was initially studied in research on phobias (Bandura 1977), and since, the highly self-efficacious person has been shown to exhibit qualities of resilience and perseverance, a notable capacity to set incremental goals, and a high level of achievement on set tasks (Zimmerman 2000).

The qualities exhibited by a self-efficacious person and the relationship of these beliefs to attainment hold clear relevance for the performing musician. Musicians spend countless hours refining their skills. While studies in academic settings have begun to unpick various components of self-efficacy and have created tools for investigating self-efficacy beliefs, they have featured in only two studies within music. McCormick and McPherson (2003) first explored the predictive power of self-efficacy beliefs by asking 332 students, between the ages of 9 and 18 representing a wide variety of abilities, a single question about their anticipated results just prior to a graded music exam. In a follow-up study, McPherson and McCormick (2006) examined self-efficacy by asking a similar sample an expanded question covering the areas tested in the graded exam. Although these studies have pioneered the investigation of self-efficacy in music (and thereby offer valuable insight into this important construct), there is as of yet no agreed means of measuring it.

The research reported in this article is based on adaptations of a generalized self-efficacy questionnaire used previously in academic contexts. As these beliefs are task-specific, some authors (e.g. Schunk 1996) have suggested that a generalized measure neither adequately corresponds with a domain of functioning nor represents the skills involved in carrying out specific, domain-related tasks. Therefore, the generalized questionnaire was adapted to address music, and then two further questionnaires were devised to address self-efficacy for learning and performing specific musical tasks.

METHOD

Respondents

Music students from the Royal College of Music, London, and the University of Chichester (n=53; 16 male, 35 female), with a mean age of 22.8 years (SD=4.2), volunteered to take part in this study. A full complement of Western classical instruments (including voice) were represented in the sample.

Materials

The validated "General Self-efficacy Scale" of Sherer *et al.* (1982) was employed as the basis for a new "General Musical Self-efficacy Scale." Only minimal wording changes were made in adapting the original. For example, "When I make plans, I am certain I can make them work" became "When I plan a musical activity, I am certain I can complete it successfully."

Developments in self-efficacy research have stressed the need for specificity within a given field and correspondence to a criterial task (Bandura 2001). From the general musical scale, two specific scales for musical learning and performing were developed. The 17 items on the general scale were divided, wording of the statements was altered to correspond to either learning or performing, and statements that could be considered to relate to both were adapted for both scales. This resulted in two new scales, each containing 11 items. The word "try" from Sherer *et al.*'s original scale was changed to "work," as in "The prospect of failure in this performance will just make me work harder in preparation;" the idea of *trying* (rather than just doing) was not considered conducive to painting an accurate picture of beliefs in one's abilities (cf. Bandura 2001).

Finally, statements in the learning and performing scales were made task-specific (i.e. oriented to a particular goal or event) through a preceding instruction that asked respondents to recall a recent performance in which they held a prominent role (e.g. as a soloist), to imagine that they were to perform a similar program in the next few weeks, and then to respond to the statements with this task in mind. Six items on each of the learning and performing scales were reverse coded.

Procedure

Respondents completed the questionnaires online, and a researcher was present to oversee this process. Students indicated each response on a 7-point Likert-type scale from 1 (disagree) to 7 (agree). Participants also rated their own ability with reference to their peers along 22 separate musical skills and attributes, from 1 (much less) to 7 (excellent), and completed a new questionnaire on musical self-regulated learning based on Zimmerman and Martinez-Pons's (1988) "Self-regulated Learning Interview Schedule" (see Ritchie and Williamon 2007).

RESULTS

Each scale as a whole and its internal components were tested for reliability using Cronbach alpha (α) coefficients. The general musical self-efficacy scale produced α=0.83. The learning scale produced α=0.78, and its components were robust. The performing scale initially yielded α=0.68, just below the established boundary of acceptability at 0.70. The deletion of two scale items raised the overall reliability of the scale, α=0.74. The reverse coded items were converted, and casewise summative scores were created for the three scales, with high scores representing high self-efficacy beliefs.

Pearson correlations yielded the following relationships between the summative scores for the three questionnaires: general-learning (r=0.59, p<0.01), general-performing (r=0.57, p<0.01), learning-performing (r=0.64, p<0.01). The normalized mean scores (i.e. with each score converted to 100% of the maximum score) were: general=75.71 (SD=11.26, SE=1.56), learning=83.41 (SD=11.00, SE=1.51), and performing=79.06 (SD=11.47, SE=1.59).

A repeated measures analysis of variance (ANOVA) was carried out with the scores from the three musical self-efficacy measures as the within-subjects factors and gender (male=16, female=35) as the between-subjects factor. There were no significant differences between men and women's self-efficacy scores overall. There were significant differences between the different self-efficacy questionnaires, $F(2,98)=11.46$, $p<0.01$, partial $\eta^2=0.05$. Furthermore, polynomial contrasts showed a significant linear effect, indicating that scores to the learning scale were higher than the performing scale, $F(1,49)=8.43$, $p<0.01$, partial $\eta^2=0.04$, and a significant quadratic effect, showing a difference between the general scale and the learning and performing scales combined $F(1,49)=14.21$, $p<0.01$, partial $\eta^2=0.07$.

Pearson correlations were run to examine the relationship between students' self-efficacy scores and their ratings of their own ability with regard to 22 musical skills and attributes. Table 1 lists the significant correlations between these skills and the three self-efficacy scales; the general scale alone corresponded to six additional skills not listed in the table.

Table 1. Pearson correlation coefficients showing the relationship between musician's skills and attributes and the general, learning, and performing self-efficacy scales.

Skills and attributes	*General*	*Learning*	*Performing*
Quality/effectiveness of practice	0.53**	0.36*	0.30*
Musicality, interpretative or expressive skills		0.42*	
Level of perseverance	0.63**	0.30*	
Ability to manage stage fright			0.41*
Motivation and drive to excel	0.60**	0.30*	
Overall standard of performance	0.37*		0.30*

* p<0.05, ** p<0.01

Also, Pearson correlations were run between the self-efficacy scores and the summative self-regulated learning score, as well as that questionnaire's ten component questions. Significant correlations emerged between the item "seek assistance from peers, teachers, or others" and self-efficacy for musical learning (r=0.37, p<0.01) and self-efficacy for performing (r=0.29, p<0.05).

DISCUSSION

Self-efficacy beliefs are, by definition, task-specific (i.e. beliefs in the ability to carry out an action successfully) and not general beliefs about skills, even within a given field. The significant differences between the specific learning and performing scales reported here—and moreover the differences between these scales and the general scale—demonstrate the need for measurement specificity within a field according to task demands. The general scale, without having the specificity found in the learning or performing scales, reveals information not about musical self-efficacy but self-beliefs that may be considered part of a wider musical self-image.

Having insight into self-efficacy beliefs is important for both students and teachers. Academic studies (Zimmerman *et al.* 1992) have shown self-efficacy to be the greatest predictor of attainment, and this is supported by research in music (McPherson and McCormick 2006). Clearly, a predictor of attainment is desirable in such an attainment-oriented discipline.

Although the research presented here offers new means of measuring self-efficacy for learning and performing, further research using these scales should investigate the relationships of self-efficacy for musical learning and specific self-regulated learning behaviors, as well as self-efficacy for performing and actual performance attainment. It has already been shown that both musical self-efficacy for learning and for performing correlate with participants' current level of seeking assistance from peers, teachers, and others. The different skills that correlate with the specific musical self-efficacy scales (see Table 1) provide researchers further pathways to study these beliefs; qualities of the self-efficacious person, such as perseverance, resilience, and achieving highly (Zimmerman 2000), may be studied in relation to various manifestations of these skills. Furthermore, examining the learning process through self-regulation, practiced in preparation for certain set tasks, could reveal a more multifaceted picture of self-efficacy beliefs. These behaviors and their interrelationships need to be explored further and in detail from students' and their teachers' perspectives in order to achieve a full understanding of self-efficacy beliefs in music.

Gaining insight into specific musical self-efficacy beliefs promises to offer a significant advancements in formulating methods for enhancing student learning and attainment in a self-directed, self-originated way.

Acknowledgments

We wish to thank Graham Welch and the *Investigating Musical Performance* team for their assistance in piloting the self-efficacy and self-regulated learning questionnaires.

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References

Bandura A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, pp. 191-215.

Bandura A. (1996). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, New Jersey, USA: Prentice Hall.

Bandura A. (2001). *Guide for Constructing Self-efficacy Scales* (revised). Available from F. Pajares, Emory University.

McCormick J. and McPherson G. (2003). The role of self-efficacy in a musical performance. *Psychology of Music, 31*, pp. 37-51.

McPherson G. and McCormick J. (2006). Self-efficacy and music performance. *Psychology of Music, 34*, pp. 332-336.

Ritchie L. and Williamon A. (2007). Self-regulated learning in music. Paper presented at the *Conference on Musical Learning and Teaching*, Rochester, Michigan, USA.

Sherer M., Maddux J., Mercandante B., Prentice-Dunn S., Jacobs B., and Rogers R. (1982). The self-efficacy scale: Construction and validation. *Psychological Review, 51*, pp. 663-671.

Schunk D. (1996). Self-efficacy for learning and performance. Paper presented at the *Annual Meeting of the American Research Association,* New York.

Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology. 25,* pp. 82-91.

Zimmerman B., Bandura A., and Martinez-Pons M. (1992). Self-motivation for academic achievement: The role of self-efficacy and personal goal setting. *American Education Research Journal, 29*, pp. 663-676.

Zimmerman B. and Martinez-Pons M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology, 80*, pp. 284-290.

Thematic session: Performance analysis II

International Symposium on Performance Science
ISBN 978-90-9022484-8

Virtuosity: Some (quasi phenomenological) thoughts

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This main goal of this paper is to discuss music performance in terms of what is called virtuosity. There is a certain view of music performance that gives emphasis to what the public and music theorists call "virtuosity in music". It appears that certain performances—of *virtuosi*—are more relevant, more accurate, more expressive, more fluent, more impressive, more (or less) something. Even certain music works apparently were design to be played specifically by virtuosi: to be performed with virtuosity. This paper proposes a possible phenomenological, social, and cultural approach to virtuosity, suggesting definitions, implications, and different types of virtuosity. It recalls the ideas of theorists (Adorno, Kant, José Gil, Merleau-Ponti) and of music aesthetics (Jankelevitch, Brelet, Rahn, Collins) concerning performance, musical works, and virtuosity. In doing so it confronts anthropological theories, semiotics, and the multiple music practice, proposing different kinds and different ways to understand virtuosity. It also questions the values and the use of this noun as meaningful in terms of music theory, or simply indicative of a tendency when understanding music performance.

Keywords: virtuoso; virtuosity; performance; music culture; semiotics

The words virtuosity, *virtuosism*, and virtuoso/virtuosi lead us to very interesting views: *virtuosi* are those who practice different virtues such as perseverance, charity, honesty; but also *virtuosi* are persons with special demiurgic powers, capable of doing things that commoners can only dream of.

We do not know for sure how morally *virtuoso* Orpheus was or which vices he fought. We know that he enchanted wild beasts with his music. Even

Hades, master of death, was delighted by Orpheus's lira. The myth of Orpheus shows us musical beauty and expressiveness as an extreme bond between performer and listener, and reflects the power of sound structures to captivate will. This is, in my view, one of the faces of musical virtuosity—the Orphic virtuosity.

Virtuosity also means the possibility to bypass some kind of impossibility. In the empirical world, in manual inventions, relationships, communication, or anywhere that a body is present as a subject, virtuosity is the capacity to go beyond reality, to cheat triviality. Virtuosity reinvents a—perhaps diabolic—body capable, as Prometheus, of touching the untouchable: closer to the absolute, to the gnosis, to the Gods.

MAIN CONTRIBUTION

Musical virtuosity

Virtuosity is a very common word used in the musical world: Clementi, Dussek, Paganini, Talberg, Mosheles were known as *virtuosi*. Liszt, a *virtuoso* of the piano, was seen as an amazing improviser, perhaps the *nec plus ultra* of virtuosity. Before him virtuosity was seen in many other composer/performers, such as the devilish Tartini, the widely known *prete rosso* Vivaldi, and Domenico Scarlatti. Some people also see J. S. Bach as a *virtuoso* because of his virtues as a composer and as a performer. He not only composed pieces which reveal incredible counterpoint technique but he also composed, played, and improvised publicly *virtuosic* pieces (*toccatas*, *fantasies, suites*). Francesco Landini, of the Italian *trecento,* was also a great composer, a distinguished poet, and a brilliant blind player of several instruments, especially the portative organ. Could we say that he was a *virtuoso* of this instrument?

Virtuosity as sacrifice: Prometheus

Virtuoso performances are, at first, a kind of circus performance, where the Olympic motto *Citius, Altius, Fortius* (swifter, higher, stronger) characterizes specific virtues in musical performance. As in a circus, performers are supposed to increase and overlap their body restrictions, or even to forget their own body and physical pain, in order to produce a series of movements with a musical instrument, resulting hopefully in structured sounds: in music. Virtuoso performers play the instrument very fast or very slow, very strong, or for a very long time; but most important is that it has to be somehow understood by the audience as an amazing musical performance. The audience has to be astonished by the performance, or their expectations of astonishment have to be fulfilled.

Interesting in this matter is the understanding of performance as a kind of civilized emulation of an ancient ritual of human sacrifices (Collins 1994, Adorno 2002). In these ancient rituals, the public, avid of blood, expects the killing of a virgin or of a young person—symbols of purity or innocence—by the hands of a wise person—a priest. This ritual assassination, a cruel act with no other purpose than the sacrifice itself, will calm the gods and the public, conscientious of the generosity of the gift—a young pure person, the purest among the community, perhaps a son or daughter of the priest or of the noble ones. Most important though, the ritual assassination will calm down the frustrations of the public and their anthropological need to fulfill violence and death. As we know, animals substituted humans in ritual sacrifices. Even drama—in the theatre, in opera, even in television series and soap operas—with its capacity to show expressive chunks of compressed and enclosed reality, serve as substitutes to our ancestors' ritual murder: the blood is only symbolized in the antagonism of the theatrical situations, ending, in a very civilized way, with the death (as in Sofocles's *Oedipus* or Verdi's *Rigoletto*), capture of the bad guys (in Dirty Harry films), or the marriage of the antagonist families "until death do us apart" (in Shakespeare's Romeo and Juliet and Brazilian soap operas). In music performance, especially in a virtuoso performance, the blood is symbolized by the conflict between the performer and his physical limitations, or between the performer and the exigencies of the music he's supposed to play; or, in a very scholarly way, by the conflict between performer and instrument.

Virtuosity as seduction: Orpheus

The Olympic Promethean performance is, in my view, only one of the faces of musical virtuosity. An Orphic version of virtuosity is a little subtler.

Many people appreciate in musical performance, besides the excitement of more or less inebriant virtuoso cascades of sounds, the beautiful sound qualities of a musician, the exuberance of the expressive means employed, or the subtleties of an intense *cantabile*. Sometimes it seems that the music performed in a violin or in a clarinet speaks like a voice, having comparable subtle changes of rhythm, dynamics, attacks, or timbre.

Virtuosity as seduction: Touching the sublime

Such a view of virtuosity is reminiscent of the concept of sublime, a level of appreciation applied, according to Kant (1911, p. 98), to the fine arts: “the sublime is that, the mere capacity of thinking which evidences a faculty of mind transcending every standard of sense.” A sublime performance—in my view both in a bullfight and in music—touches the absolute and sets in motion the public’s mind, reacting at first with repulsion but quickly changing to attraction (Kant 1911, p. 107). Sublime performances are not a function concerning only the body of the performer, or the body of the performing elements: they concern all subjects and all the circumstances present. The body is also the public, the instrument, the place, the time, and the public’s (or subject’s) psychological conditions.

Musical virtuosity: First suggestions

The body

It seems that the body of the performer is somehow important for some virtuoso musical performances. Virtuosity needs the mastering of the body, enabling the performance of musical works that seem to be incredibly difficult (or incredible performances of one apparently not so difficult work). This bodily virtuosity can manifest in two ways. In the first instance, the performance seems to go beyond physical frontiers. The body is an obstacle, an impediment that the virtuoso has to overcome. It seems then that the performer is liberated from those bodily restraints; the music flows and seems to be easy; there is no unpleasant or fearful body there, no restrictions for the pleasure of musical virtuosity. Secondly, virtuosity can also be seen as the apotheoses of the body, here understood as an opponent that has to be conquered. Mastering the body (movements, tensions, time), enables the performance of prodigious works, composed in an intentional sadistic and devilish way, intended to be a torture, to be conquered by the performer.

The sublime

Orphic virtuosity has, in this analysis, different properties: virtuosity can be seen as the revelation, the presence, or evidence of the sublime. I would like to show two slightly different ways of musical sublimity.

1. One of the ways of experiencing this sublimity is when a performance seems to be a unique moment of communication, an exceptional symbiosis of the subject (the public), the performer, and the context; a

moment, or circumstance, characterized not only by a common frame of cultural references but specifically by a common symbolic language including sound, movements, ambiance, and time.

2. A second slightly different view is what can be called "expressive ecstasy." In this case, the performance is understood as an enormous flow of expressive musical forms. It assumes the premise that music is utterly expressive or that it can provoke emotive experiences on the public. The expressive ecstasy is the astonishment in face of an overwhelming emotional moment.

Musical virtuosity: Second suggestions

Virtuosity raises, however, some other questions relevant by its nature as communicational phenomena between listener and performer.

1. Virtuosity: any kind of virtuosity is just a way of understanding performance. It is utterly *aesthesis*, an understanding of a communicational act as a function and as a specific moment.
2. To assess whether a specific performance is (or is not) a virtuosic performance remains something confined to the time, place, instruments, ambiance, and circumstances of performance.
3. Virtuosity has been measured—quicker, lighter, more expressive, more authentic— and is becoming a surplus commodity, which can be exchanged in the commerce of cultural goods.

IMPLICATIONS

Virtuosity seems to have been present in western music since the end of the Middle Ages. It is associated with the assumption of an authorship and of music making as a creative unique act. It is also associated with the social evolution of music reception and music making, becoming a business product. Yet, it is much more a question of the conditions of the reception as something intrinsic to the performance itself. It is, sometimes, a mere illusion.

Virtuosity is also a peculiar view over music performance, which is the interpretation of a musical work resulting in its transformation in music: structured sounds that are actually heard. Mind, body, and context are always very meaningful for the performer, the instrument (an extension of the performer's body), and for the listener. Risk, will, passion, excitement, and extreme feelings also seem to be very present whereas security, inattention, normality, regularity, conformity, and lack of feelings are far from virtuosity.

To be a virtuoso means to take risks, to amaze, to move; to understand virtuosity means to confirm a victory, to accept a challenge, to be amazed and to be moved by a performance.

The study of virtuosity raises many questions regarding the understanding of music performance in time and space, such as the social understanding of music, the relationships between composition, performance and reception, the ways people appreciate music in different contexts, the possibilities of performance, and the meaning of different types of music performance in music education. These thoughts and suggestions serve to help assemble a conceptual ground, a comprehensive theoretical basis for further empirical and theoretical researches in music performance.

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References

Adorno T. W. (2002). *Quasi una Fantasia*. London: Verso.

Brelet G. (1951). *L'Interpretation Créatice*. Paris: PUF.

Collins D. (1994). Ritual sacrifice and political economy of music. In J. Rahn (ed.), *Perspectives on Musical Aesthetics* (pp 9-20). New York: W. W. Norton.

Csepregi. G. (2001). La Musique et le corps, Vladimir Jankélévitch sur l'art du piano. In G. Csepregi (ed.), *Sagesse du Corps* (pp 103-114). Aylmer, Québec, Canada: Éditions du Scribe.

Gil J. (1980). *Metamorfoses do corpo*. Lisbon: A Regra do Jogo.

Hofstadter D. R. (1999). *Gödel, Escher, Bach*. New York: Basic Books.

Horkheimer M. and Adorno T. W. (1997). *Dialéctica de la Ilustración*. Valladolid, Spain: Simancas Ed.

Jankelevitch Vl. (1979). *Liszt et la Rhapsodie, Essai sur la Virtuosité*. Paris: Plon.

Kant E. (1911). *Critique of Aesthetic Judjement*. Oxford: Clarendon Press.

Merleau-Ponti M. (1945). *Phénoménologie de la Perception*. Paris: Gallimard.

Morgan R. (1999). *La Música del Siglo XX*. Madrid: Akal.

Rahn J. (1994). What is valuable in art, and can music still achieve it? In J. Rahn (ed.), *Perspectives on Musical Aesthetics* (pp 54-65). New York: W. W. Norton.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The art of hand-splitting: Vianna da Motta's contribution toward a better rendering of Beethoven's sonata op. 31/2

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Vianna da Motta's note-distribution in Beethoven's sonata op. 31/2 alters the composer's original notation in a significant manner. The discussion lies on whether these changes may help to emphasize the musical intentions or if by facilitating the execution of some passages, the musical result may be subverted. While some pianists simply object to this practice, others believe it may bring advantages in the sense that by reducing the technical difficulties of a particular passage one can better concentrate on the musical result. Through the analysis of some of the most relevant of Vianna da Motta's hand-splitting solutions it is concluded that they are an objective vehicle toward a better rendering of the work both technically and musically, providing at the same time fertile ground for further individual findings.

Keywords: hand-splitting; piano; performance; Vianna da Motta; Beethoven

Distributing notes between the hands in a different way than notated by the composer is a practice that is not unanimously accepted among pianists. Polini, Serkin, Arrau, and Eschenbach are totally against it, Barenboim acknowledges it in Rachmaninoff or Tchaikovsky but never in Beethoven, and Perahia, Brendel, Richter, and Stefan Askenase believe it to be a useful practice (Meyer-Josten 1989). Older pianists also disagree on this matter: Schnabel "objected violently to the constant hand-splitting of the pianists of the Liszt school" (Wolf 1972, p. 117), while Cortot believed namely in splitting the octaves at the beginning of Beethoven's op. 111. (Thieffry 1986). As a faithful heir of his masters Liszt and Bülow, the Portuguese José Vianna da Motta (1868-1948) was described by his former pupil and biographer João de

Freitas Branco as having the ability to discover the most "ingenious solutions which, once learned, seemed as Columbus's egg." Branco also emphasized the fact that "the distribution of the notes between the hands, changing some from the right to the left, or the other way around, facilitated a great deal the execution of particularly transcendental passages" (Branco 1987, pp. 111-112).

Vianna da Motta's editorial work, particularly of Beethoven, reveals an extreme attention to performance details, notably through the introduction of numerous fingering alternatives in which hand-splitting suggestions play an important role (for a detailed analysis of da Motta's unpublished edition of Beethoven's op. 7, see Pipa 2004). His only printed edition of a Beethoven sonata was that of op. 31/2, issued by Sassetti in Lisbon, a work in which Vianna da Motta rearranges the text in order to overcome the difficulties of Beethoven's writing. Another of his distinguished disciples, composer and pianist Fernando Lopes-Graça, noted that by the time the edition was released it caused a certain "degree of scandal, due to its scant respect for the orthography of the original text" (Lopes-Graça 1984, p. 20). This article analyzes some of the most significant of da Motta's hand-splitting suggestions to op. 31/2 and how they may contribute to improve the performance of the work.

MAIN CONTRIBUTION

A case for hand-splitting

The main objection to changing a composer's note distribution lies on the argument that it may alter the original musical intention. A classic case mentioned by Barenboim and Eschenbach is the beginning of Beethoven's op. 106. Both pianists argue that the left-hand jump is essential to preserve the musical tension, therefore ruling out the possibility of playing the first b-flat chord with the right hand (Meyer-Josten 1989, pp. 53 and 105). Brendel, on the other hand, sees no reason why an even greater tension could not be achieved with the arrangement, finding it absurd to play the passage with the left hand only at the "fast and fiery tempo" claimed by Beethoven, according to Czerny's account (Meyer-Josten 1989, p. 70). Stefan Askenase believes that if one can get greater confidence in playing the passage by arranging it, it may even help to emphasize the musical tension (Meyer-Josten 1989, p. 43). Cortot's aforementioned advice to split the two octaves at the beginning of op. 111 is grounded on the wish to portray the strong and heavy character of the introduction, seen by the French pianist as an "appeal from Destiny," where the octaves should "not be played too fast" and possess the "majesty of two marble blocks" (Thieffry 1986, p. 89).

It appears from these statements that the two sides of the argument present the same reason in the defense of their cases: both believe their position to be the one better to portray the composer's musical intentions. It seems clear, however, as Askenase argues, that by reducing the technical difficulties one should be more capable of focusing on the intended musical result.

Vianna da Motta's hand-splitting suggestions for op. 31/2

It is somewhat paradoxical that having profusely adopted hand-splitting alternatives throughout the entire sonata, Vianna da Motta does not suggest one for the first movement passage between bars 13 and 16, certainly one of the greatest challenges in the entire piece; partly due to coming very early in the work when the pianist is still adjusting to the performance. Written originally for the right hand alone, the articulation in every two notes could also be further emphasized by a division of the passage. Furthermore, the "deciso" and "impetuoso" character intended by da Motta would benefit from the added strength of this division (see Figure 1).

The next controversial passage begins in bar 21 of the same movement. da Motta's arrangement—playing the bass note of bar 22 with the left-hand thumb and silently changing it to the fifth finger while keeping the middle-voice triplets in the right hand until resuming them with the left hand on the third beat—is extremely clever. It avoids attacking the last note of the D minor arpeggio of the bass line with the left hand together with the triplet motive, which most likely would cause the first note of the triplets to be heavier than aimed for (see Figure 2). Schnabel objected to any arrangement of this passage (Wolf 1972), and that is reflected in his own edition where he takes both notes with the left hand as originally notated. He would, however, eventually praise da Motta's suggestion, as it undoubtedly separates the voices in an absolutely clear manner.

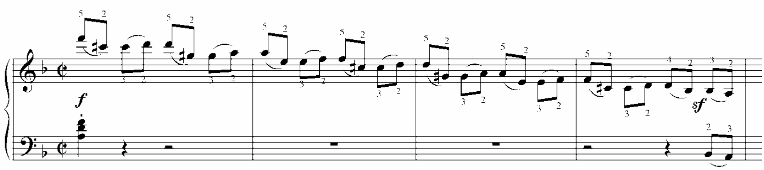

Figure 1. Beethoven Sonata op. 31/2, first movement, bars 13-16 (hand-splitting possibility).

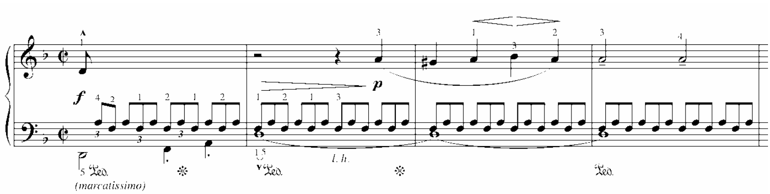

Figure 2. Beethoven Sonata op. 31/2, first movement, bars 21-24 (Vianna da Motta's hand-splitting).

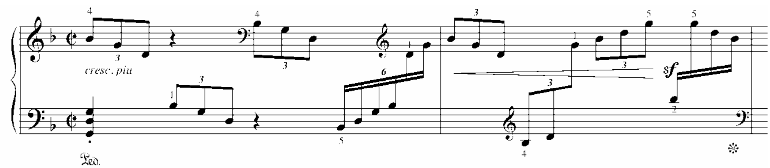

Figure 3. Beethoven Sonata op. 31/2, first movement, bars 165-166 (Second arpeggio sequence with Vianna da Motta's hand-splitting).

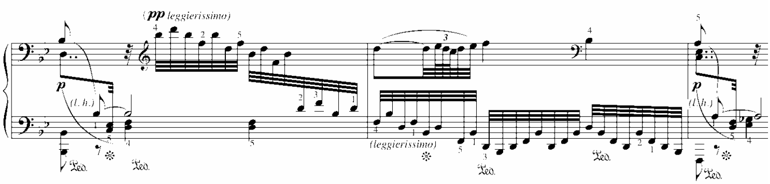

Figure 4. Beethoven Sonata op. 31/2, second movement, bars 51-52 (Vianna da Motta's hand-splitting).

The three arpeggio sequences between bars 161 and 170 of the first movement are also contentious. Arrau believes the arpeggios should be played with the right hand only since, in his opinion, the composer was trying to express something difficult and hard (Elder 1986). da Motta divides the passage between both hands, particularly interesting being the arrangement of the second and third sequences where the *sforzato* notes are attacked with the left hand over the right, helping further to emphasize their expressive meaning (see Figure 3).

The second movement has two passages in which the notated hand-crossings cause significant discomfort to the performer. The first, starting in bar 23, keeps a chordal sequence in the right hand while a percussive triplet motive is played by the left hand in the lower and upper registers. da Motta attributes his division to a Reineke suggestion (curiously, Casella mentions

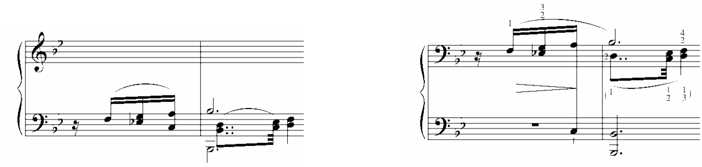

Figure 5. Beethoven Sonata op. 31/2, second movement, bars 8-9 (Beethoven's original writing and Vianna da Motta's hand-splitting).

Klindworth's revision of the 1919 Ricordi edition) in which he avoids the crossings by alternating the chords between the right and left hands. The second passage, starting in bar 51, avoids crossing the hands through the use of a clever device: the silent replacement by the left hand of the upper note of the first beat in every second bar, allowing the hands to interchange roles (see Figure 4). Again, Casella mentions Klindworth (or Henselt in the German translation, possibly a mistake) as the author of this modification.

In any case, these two passages reflect da Motta's concern for finding an easier and more effective way of performance. It is essential though that the interpreter preserves the balance of the parts when changing them from one hand to the other. This more comfortable manner namely implies an added control over the weight of each voice within the chords. Were this aspect to be neglected, any advantage attained through the avoidance of the hand-crossings would be lost.

One last example is revealing of Vianna da Motta's attention to the smallest details. The subtle introduction of the left-hand thumb on the C and the B-flat at the last note of bar 8 and the first of bar 9 of the second movement creates a smooth legato, impossible to achieve with the original distribution. The fingering in brackets in bar 9 is my own alternative in which the hand is kept in a more relaxed position (see Figure 5).

IMPLICATIONS

A simplified manner of fingering by dividing passages between the hands enables the performer to tackle a work with greater confidence by deliberately reducing the risks in particularly difficult passages. In this sense, arrangements should be encouraged as a means of rendering in the best possible manner the pursued musical result. Radical positions against this practice such as the ones held by some pianists can only result in an impoverishing of the range of possibilities in the process of searching for that result. In this sense, Vianna da Motta's edition of Beethoven Sonata op.31/2 presents solutions that, more than just making certain passages easier to perform, clearly aim at a specific musical enhancement of the work and may serve as a starting point for further individual findings in the pursuit of evermore stimulating and meaningful performances.

Acknowledgments

My sincere thanks go to Carlos Meireles for his help and patience throughout the process of choosing and creating the musical examples.

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References

Branco J. F. (1987). *Viana da Mota*. Lisbon: Gulbenkian Foundation.

Elder D. (1986). *Pianists at Play*. London: Kahn and Averill.

Lopes-Graça F. (1984). Viana da Mota: Subsídios para uma biografia incluindo 22 cartas ao autor. In F. Lopes-Graça (ed.), *Opúsculos 3* (pp. 9-94). Lisbon: Editorial Caminho.

Meyer-Josten J. (1989). *Conversations*. Paris: Editions van de Velde.

Pipa L. (2004). *From the Romantic Tradition to the Modern School of Pianism: The Legacy of José Vianna da Motta (1868-1948).* Unpublished doctoral thesis, University of Leeds.

Thieffry J. (1986). *Alfred Cortot: Curso de interpretação*. Brasília: Editora Musimed.

Wolff K. (1972). *The Teaching of Artur Schnabel*. London: Faber and Faber.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Fernando Lopes-Graça's choral music: Characteristics and interpretation

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Fernando Lopes-Graça's choral music was frequently performed with harshness. His connection to traditional music, his ideology and that of most choirs who performed it, and the influence of his politically-engaged songs gave rise to a style of interpretation that often had nothing to do with the music itself. On the basis of the analysis of some of his vocal compositions, this paper attempts to demonstrate that Lopes-Graça was, in most cases, a composer full of lyricism, a sensitive conveyor of natural, social, and poetic atmospheres, who has often been interpreted in an inaccurate and artificial way. This paper is based on the analysis of parts of the works *Quatro Redondilhas de Camões*, *Dos Romances Viejos*, *Três Esconjuros* and *Para as raparigas de Coimbra*, using musical examples from recent CD recordings by the Gulbenkian Choir. The way Lopes-Graça handles dissonance must, in most cases, be regarded as a sequence of colors, a subtle conveyance of emotional atmospheres, and only secondarily as an alternation of tensions. Indeed, the very concept of dissonance must be reconsidered in terms of his own music.

Keywords: Fernando Lopes-Graça; choral music; analysis of recordings; dissonance

Fernando Lopes-Graça's choral music is a whole consisting of harmonizations of folk songs (Portuguese songs for the most part) and original works.

Contrary to the "folkloristic" harmonizations promoted by the earlier regime, which have a simple harmony and were rhythmically and metrically regular, Lopes-Graça's folk songs are harmonically complex and have an irregular and asymmetrical rhythm and meter.

> The Portuguese popular song maintains, as few ones do, the essence, the smell of the earth, the mark of its rural origin, the seal of its authenticity and popular inspiration. It is practically always a true native product, and not a transformation or adaptation…of the learned creation (Lopes-Graça 1974, p.32).

The original music, with its own language, maintains some characteristics of harmonizations of folk songs:

1. Communicability (i.e. harmonizations of folk songs were intended to be sung by amateur choirs, by the "singing common people").
2. A syllabic style.
3. A clear, intelligible, and very natural articulation.
4. A high degree of freedom as regards rhythm and bar divisions, which is largely conditioned by spoken text and prosody, with asymmetries, hemioles, and unpredictable subdivisions (i.e. *Três Esconjuros*, No. 2).

MAIN CONTRIBUTION

Fernando Lopes-Graça was an educated man, a connoisseur and lover of the great Portuguese poetry. On the other hand, he was also an experienced choral conductor, acquainted with vocal technique and the expressive potentialities of the voice. Consequently, he always composed in a natural way and with an enormous sense of prosody. In his music, the phonetics of the poem is structural, standing ahead of the purely melodic construction of the singing.

The melody is sometimes related to modes and has ornamental melismatic motives typical of the Mediterranean folk music (i.e. *Dos Romances Viejos*, No. 2).

Lopes-Graça is sober in expressing emotions and feelings, using subtle and interior processes, never becoming superficial nor looking for easy effects. Nevertheless he always manages to translate clearly the atmosphere of his texts:

1. Through the melodic-harmonic structure itself (i.e. *Quatro Redondilhas de Camões*, No. 4, cc. 27-53: the static nature of the scene is given by the two lower voices, while the two higher voices, holding the poetic sequence of the text, are more agitated and discursive).
2. Through the melodic construction.

DóM	Mibm	DóM	Solm	Dóm	Fám	DóM	DóM
c.1	c.3	c.4	c.7	c.7	c.10	c.10	c.15-18

Dóm	Solm	Fám	Solm	Dóm	Fám	DóM	Dóm	DóbM	FábM	Dóm	Sibm
c.23	c.23	c.24	c.29	c.29	c.31	c.31	c.33	c.35-6	c.38	c.40	c.41

Dóm	SibM	Fám	Solm	Solm	Dóm	Fám	DóM
c.46	c.46	c.47	c.47	c.52	c.52	c.54	c.54

Figure 1. Redondilhas de Camões, No. 2. Global harmonic passage.

3. Through the melodic effects (i.e. *Três Esconjuros*, No. 3, the male voices as thunders).
4. Through a complex rhythmic overlapping with different beats, the most frequent being the 3 over 2 (i.e. *Para as raparigas de Coimbra*, cc. 3-15: the psychological density is given not by the main melody, which is rather simple, but by the intricate rhythmic overlapping of the accompanying voices).
5. Through the dynamic effects.
6. Through the consecutive movement changes in different sections (i.e. *Dos Romances Viejos*, No. 1: action, drama, anxiety, nostalgia, sadness).

Regarding harmony, we cannot speak of tonality or atonality in the traditional concepts. In general, there is a sense of tonality, more or less clear in different works, that can be explained by a group of tension and distension peaks, among which we find chromaticism and dissonance. There are many 4th and 5th chords, and 2nd and 7th dissonances alternate frequently with perfect chords (i.e. *Quatro Redondilhas de Camões*, nº 2).

If, on the one hand, these perfect chords establish a tonal mood in the piece with a relatively clear function and, in doing so, create an unmistakable group of tension and distension peaks, on the other hand the dissonant chords between them cannot be regarded as dissonances in the sense of tension that would lead to a wild harmonic atmosphere, but rather as a sequence of colors which provide a subtle conveyance of emotional atmospheres. A chord ceases to be considered consonant or dissonant and becomes a color, an aquarelle stroke related to a syllable or a word; an ambient of the text. To consider dissonances as tensions, without looking instead for the subtleness of colors, was one of the reasons that contributed to a rude interpretation style of Lopes-Graça music.

As in many other pieces, there is in *Falso cavaleiro ingrato* (*Redondilhas de Camões*, No. 2) an extraordinary connection between the harmonic atmosphere, with its unstable balance among functionality and color, light and shadow, open colors and subtle nuances, and the ambiguity of *Redondilhas de Camões*, in which hatred and love mix, merge, and co-exist.

Lopes-Graça's choral music has frequently been performed with some harshness by some of his interpreters, which has nothing to do with the music itself. This tendency should not be generalized however; among others, Borges Coelho with Coral de Letras da Universidade do Porto, Teresita Gutierrez Marques with Coro de Câmara de Lisboa, and Francisco d'Orey with several choirs have acknowledged and stressed the poetry and the lyricism in Lopes-Graça' choral songs.

For that rough performance style that damaged the image that Lopes-Graça's music left in certain environments and that contributed to leave it far from important auditoriums, we must find reasons:

1. The treatment of dissonances, of which we have already spoken.
2. As the composer was closely related to a left-wing party, his songs, regardless of the subject, were often used more as pamphlets than as autonomous and universal art works (most choirs that continuously performed Lopes-Graça's songs were ideologically close to the composer).
3. Politically-engaged songs, namely the *Canções Heróicas*, that represent a very small part of his vocal creation, acquired, specially in the period after the revolution, a great importance and popularity and they became in certain environments the flag of the composer, linking to Lopes-Graça's musical image and conditioning the interpretation of other types of songs, which also adopted a "heroic and rude style."
4. Lopes-Graça's own style in the performance of his works, vigorous, energetic, and not so prone to lyrical manifestations. In his own words, in 1974: "...thus, to a Wagner or a Mahler, 'hyper-expressive' musicians, I prefer a Debussy or a Stravinsky, not 'anti-expressive' musicians...but where the expression is restrained to the reasonable borders in which the music may be conceived as an 'expressive' art" (Lopes-Graça 1978, p. 128).

IMPLICATIONS

Then, what should a Lopes-Graça's choral music interpreter do?

1. He must focus on the work itself, without any type of preconceptions.

> Every great musical work is an organism that includes in itself…its own beginning, middle, and end, an entity that contains in itself its own reason…Even if in his work there is a lot of the life of the artist, of his fights or his triumphs, of his rejoicing or his misery,…that work, however, if it has succeeded passing from the subjective to the objective, enlarged from the individual to the universal, ascended from "the particular to the general", that is, if it has moved from a personal contingence level to an aesthetic need level,…that work possesses immediately an entity of its own, that will be studied, interpreted, understood according to its internal structure, to its immediate reality (Lopes-Graça 1978, pp. 185-186).

2. He must be flexible, and search a natural and discursive phrasing, closely related to the spoken text.
3. He must only analyze, understand, find once more the sensibility, the lyricism, the cleverness, and the subtleness Lopes-Graça showed when he composed, and absolutely nothing else.

> The sound work is a complicated organism, an organized body, in which all parts adjust according to an accurate logic. Previously to a performance, the artist *dissembles* the work, analyzes it, *listens* to it, in order to *understand its life*; afterwards, he takes the opposite direction: *he brings it together*, operates the summary of what he has observed – and the result is that there is no chord, there is no dynamics gradation, there in not a note that has not been *thought* of according to what it represents in the economy of the work (Lopes-Graça 1978, p. 173).

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References

Lopes-Graça F. (1974). *A Canção Popular Portuguesa*. Lisbon: Ed. Europa-América.
Lopes-Graça F. (1978). *Reflexões Sobre a Música*. Lisbon: Ed. Cosmos.

Graduate award paper

International Symposium on Performance Science
ISBN 978-90-9022484-8

Neural correlates of professional classical singing

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We evaluated cerebral activation maps of 43 subjects with respect to their classical singing skills. Professional opera singers, music conservatory vocal students, and medical students overtly sung parts of an Italian aria in a sparse sampling functional magnetic resonance (fMRI) experiment. Professional opera singers compared to medical students revealed increased activation in bilateral dorsolateral prefrontal cortex (DLPFC) and inferior parietal lobe (IPL, both pronounced in the right hemisphere), right primary somatosensory cortex (S1) in the somatotopic representation of the articulators, but also in the cerebellum and the thalamus. Vocal students compared to medical students revealed bilateral increased activation in the IPL, the DLPFC, and S1. Opera singers compared to vocal students showed increased activation in the left caudate nucleus, the left cerebellum, bilateral DLPFC, and the medial dorsal and ventrolateral thalamus. A subsequent regression analysis was performed with the amount of weekly singing practice and showed practice dependent activation of DLPFC, bilateral IPL (pronounced in the right hemisphere), and S1. A further regression analysis excluding the opera singers showed left lateralized activation in the same regions. We conclude that experienced singers developed a specialized network for enhanced somatosensory processing and performance monitoring as well as motor sequence attention.

Keywords: neuroimaging; classical singing; musicians; non-musicians; functional brain activation

Several neuroimaging studies have revealed experience dependent plasticity in the primary motor and somatosensory cortices, the cerebellum, the anterior corpus callosum, as well as the fiber tract organization in white matter of instrumental musicians (Bengtsson *et al.* 2005, Gaser and Schlaug 2003, Hutchinson *et al.* 2003). Functional differences were often characterized by reduced recruitment of premotor and supplementary motor areas and a more circumscribed, as well as enhanced activation, in areas related to motor execution (Lotze *et al.* 2003). Keyboard and string players are among the musicians most often studied, mainly because of the exceptional demands on their manual dexterity. Classical singing, however, has largely been neglected.

In contrast to instrumental playing, which involves largely fine motor control of peripheral muscle groups, singing and particularly singing of classical music requires more body-core centered motor and anatomic activity of vital bodily importance, representing a complex interplay of laryngeal, respiratory, and articulatory activity (Jurgens 2002).

Sensory feedback is especially crucial for vocal control. Lesions of the sensory superior laryngeal nerve result in hoarseness and a drop of fundamental frequency (Shiba *et al.* 1995) while information on the current air volume of the lungs is required for the generation of vocal motor patterns (Nakazawa *et al.* 1997). The inhibition of sensory information from the supralaryngeal tract results in impaired articulation (Prosek 1975). Furthermore, auditory feedback is necessary for pitch accuracy (Murbe *et al.* 2002).

In a first functional magnetic resonance imaging (fMRI) study that involved professional singing, we compared overt and imagined singing of an Italian aria (Kleber *et al.* 2007). Based on the results of this study, we aimed to identify neural activation patterns of overt singing performance related to the singers' level of proficiency. We proposed that areas involved in sensory feedback control and performance monitoring will show enhanced activation in experienced singers.

METHOD

Participants

A total of 43 right handed subjects without reported history of neurological or psychiatric disease participated. Ten professional opera singers (mean age=38.07 years, range=30-44 years; 7 female), 22 professional vocal students (mean age=25.22 years, range=20-30 years; 15 female), and 11 medical students (mean age=23.54 years, range=23-29 years). Medical students had no or very little amateur singing experience (i.e. 1-5 hours per week, mean=2.6 h). Vocal students reported an average of 9.77 years singing experience (range=4-23; based on their first professional singing lesson), and 18 hours singing practice per week (range=8-30). Opera singers reported 21.03 years of singing experience (range=14-28), and 27.6 hours singing practice per week (range=20-42).

Materials

The fMRI technique applied corresponds to the one previously reported for overt and imagined singing (Kleber *et al.* 2007). Whole head scans (66 volumes per block) were performed with a 1.5 Tesla whole body Scanner (Siemens Vision) using echo planar imaging (EPI; TE: 40 ms; TR: 10 s, TA: 3 s, 36 transversal slices of 3 mm thickness and 1 mm gap, matrix 64*64). A sparse sampling method avoided movement artifacts and allowed undisturbed monitoring of own voice during singing.

Procedure

Subjects overtly sung six phrases from the Italian aria *Caro mio ben* (by Tommaso Giordani) in an fMRI scanner, performing each phrase separately after a visual cue. The aria's phrase structure fits naturally the sparse sampling technique employed. Subjects first rehearsed the task outside the scanner and then again within the scanner prior to the actual measurement. Successful task accomplishment was monitored via loud speakers.

RESULTS

Statistical maps (fixed effect) were calculated for each subject. First level contrast images of each subject were then used for group statistics calculated as random effects analysis at the second level. A one-way analysis of variance (ANOVA) with three groups (medical students, vocal students, and opera singers) was performed. Nonsphericity correction was applied to account for unequal variances due to the different group sizes. For the analysis of differential effects between groups a small volume correction was performed with apriori defined pre-selected regions of interest (ROI) based on previous results (Kleber *et al.* 2007). The statistical threshold was set as $p<0.001$ uncorrected. A second-level regression analysis explored individual differences in brain activity related to the amount of time spent with singing per week.

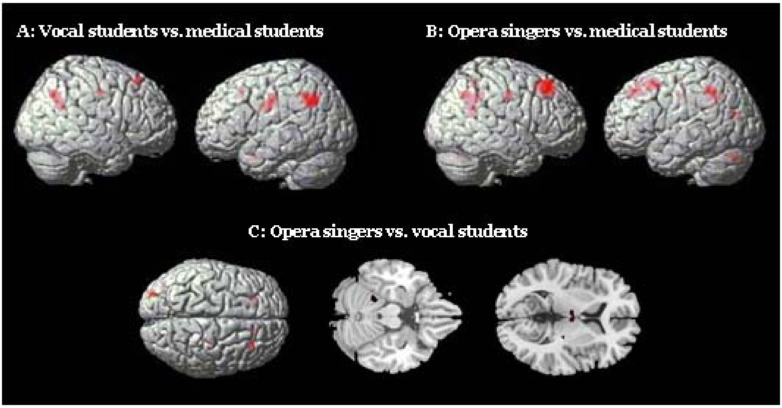

Figure 1. Examples of activation sites (p<0.001, uncorrected). (See full color version at www.performancescience.org.)

Vocal students versus medical students

Examples of activation sites are given in Figure 1a. We detected bilateral activation in the IPL (BA39/40, including the supramarginal and angular gyrus), the DLPFC (BA8/9), the bilateral primary somatosensory cortex (S1) in the somatotopic representation of the articulators, but also the left temporal pole. A subsequent regression analysis including only vocal and medical students was performed with the amount of hours spent with singing per week. Increased activation involved IPL bilaterally (BA39/40), the DLPFC (BA8/9), the left primary somatosensory cortex (S1) in the representation of the articulators, and the left temporal pole.

Opera singers versus medical students

Examples of activation sites are given in Figure 1b. We detected increased activation in the DLPFC (BA8/9, superior and middle frontal gyrus), the IPL bilaterally (BA 39/40), the primary somatosensory cortex (S1) bilaterally in the somatotopic representation of the articulators, the cerebellum (Larsell's lobule HVI and HVII), the occipital lobe (BA19), the left temporal pole and the thalamus (posterior ventral lateral nucleus).

Opera singers versus vocal students

Examples of activation sites are given in Figure 1c. We detected increased activation in the basal ganglia (left caudate nucleus), the left cerebellum

(Larsell's lobules IV/V, VII), the DLPFC (BA 8/9, middle and superior frontal gyrus), and the anterior thalami (medial dorsal and ventrolateral nuclei).

Regression analysis over all subjects: Weekly singing time

The time spent with singing per week was correlated with increased activation in the DLPFC with additional superior frontal medial cortex activation, IPL (most pronounced in the right angular and supramarginal gyrus), the right primary somatosensory cortex (S1) in the representation of the articulators, the left temporal pole, the occipital cortex (BA19), the basal ganglia, and the left thalamus (pulvinar nucleus).

DISCUSSION

We proposed that increased auditory and proprioceptive processing for vocal control in expert singers would lead to enhanced and circumscribed functional activation of areas related to somatosensory and auditory processing. Our analyses did not show enhanced auditory activation related to singing proficiency. This could be explained by diminished activity in the superior temporal gyrus that is often found during self-perception of the own voice (Houde *et al.* 2002), i.e. the auditory cortex attenuates its sensitivity during singing production and modulates its activity as a function of the expected acoustic feedback, which may cover effects related to musical ability.

However, in accordance with our hypothesis singing experience revealed enhanced activation of primary somatosensory cortex in the somatotopic representation of the articulators (Lotze *et al.* 2000).

Sensory guided adjustments of the singer's articulators are used to modulate the resonance characteristics of the vocal apparatus, which eventually results in desired qualitative changes of the vocal sound in classical singing (Sundberg 1974). The primary somatosensory cortex (S1) is thought to be part of a feedback control system for somatosensory error detection and thus contributes to accurate feedforward motor commands in classical singing (Guenther *et al.* 2006). Somatosensory state cells in S1 are supposed to process the actual somatosensory state during sound production while somatosensory error cells in the IPL detect if this state matches the desired somatosensory goal that was previously learned throughout the development of singing skills (Guenther *et al.* 2006). Error processing during singing with pitch-shifted auditory feedback has also shown to involve the IPL (Zarate and Zatorre 2005). The IPL in general is thought to contribute to verbal working memory and probably reflects a store for phonological and non-verbal short-term information (Zatorre 2001). It has shown to be involved in vibrotactile frequency discrimination and tongue movements (Soros *et al.* 2007, Watanabe *et al.* 2004) and utilizes proprioceptive feedback from the articulators for the word formation process (Jurgens 2002). This is achieved by integrating sensory and motor signals in order to accomplish sensorimotor transformations necessary for motor planning and sensory guidance of movements (Fogassi and Luppino 2005). Motor sequences require also a constant redirection of motor attention, which is attributed to the supramarginal gyrus, a subdivision of the IPL (Rushworth *et al.* 2003) that was more active in vocal students and opera singers. The angular gyrus, also increasingly active in experienced singers, has been attributed to action awareness (Farrer *et al.* in press), which refers to the processing and comparison of action intentions and action consequences. This perceived discrepancy between movement intention and consequence also involved the DLPFC. Both areas were most active in professional opera singers. The DLPFC is thought to be essential for maintaining a "task set," i.e. a representation of task goals held in memory against which one can evaluate and monitor one's own performance (Fassbender *et al.* 2004). It is specifically involved in goal-directed selection and response generation (Mitchell *et al.* 2005) and implicated in the mental preparation of a forthcoming sequential action (Pochon *et al.* 2001).

Taken together, S1, IPL and the DLPFC seem to work in concert in a feedback control system for accurate fine tuning of feedforward motor commands with regards to the achievement of performance goals in classical singing. This involves also increased attentional abilities for maintaining and manipulating information that was previously processed in posterior sensory cortices (Johnson *et al.* 2007).

Additional activation was found in the cerebellum, basal ganglia, and the thalamus of the most experienced opera singers. The cerebellum is involved in the control of complex motor sequences (Braitenberg *et al.* 1997), probably based on a feedforward prediction of the timing and the use of sensory feedback information to modify and correct subsequent movements (Zatorre *et al.* 2007). Skilled instrumentalists typically exhibit decreased cerebellar activation, probably reflecting enhanced movement efficiency in musicians (Koeneke *et al.* 2004). However, this could also be attributed to the non-musical tasks employed. Thalamic activation was focused in the medial dorsal (projecting to the prefrontal cortex) and the ventrolateral thalamus, which projects to the motor cortex and receives its main input from the cerebellum. Thalamic lesions severely affect speech production (Jurgens 2002). Functional activation related to long-term learning, i.e. when the movements become automatic, has shown to activate increasingly the basal ganglia

(Floyer-Lea and Matthews 2005), which play an important role in motor behavior related to speech (Friederici 2006) but are also involved in learning and memory functions (Packard and Knowlton 2002).

Acknowledgments

This work was supported by the Deutsche Forschungsgemeinschaft (DFG).

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References

Bengtsson S. L., Nagy Z., Skare S., *et al.* (2005). Extensive piano practicing has regionally specific effects on white matter development. *Nature Neuroscience*, *8*, pp. 1148-1150.

Braitenberg V., Heck D., and Sultan F. (1997). The detection and generation of sequences as a key to cerebellar function: Experiments and theory. *Behavioral and Brain Sciences*, *20*, pp. 229-245 (discussion pp. 245-277).

Farrer C., Frey S. H., Van Horn J. D., *et al.* (in press). The angular gyrus computes action awareness representations. *Cerebral Cortex*.

Fassbender C., Murphy K., Foxe J. J., *et al.* (2004). A topography of executive functions and their interactions revealed by functional magnetic resonance imaging. *Brain Research*, *20*, pp. 132-143.

Floyer-Lea A. and Matthews P. M. (2005). Distinguishable brain activation networks for short- and long-term motor skill learning. *Journal of Neurophysiology*, *94*, pp. 512-518.

Fogassi L. and Luppino, G. (2005). Motor functions of the parietal lobe. *Current Opinion in Neurobiology*, *15*, pp. 626-631.

Friederici A. D. (2006). What's in control of language? *Nature Neuroscience*, *9*, pp. 991-992.

Gaser C. and Schlaug G. (2003). Gray matter differences between musicians and nonmusicians. *Annals of the New York Academy of Sciences*, *999*, pp. 514-517.

Guenther F. H., Ghosh S. S., and Tourville J. A. (2006). Neural modeling and imaging of the cortical interactions underlying syllable production. *Brain and Language*, *96*, pp. 280-301.

Houde J. F., Nagarajan S. S., Sekihara K., and Merzenich M. M. (2002). Modulation of the auditory cortex during speech: An MEG study. *Journal of Cognitive Neuroscience*, *14*, pp. 1125-1138.

Hutchinson S., Lee L. H., Gaab N., and Schlaug G. (2003). Cerebellar volume of musicians. *Cerebral Cortex*, *13*, pp. 943-949.

Johnson J. A., Strafella A. P., and Zatorre R. J. (2007). The role of the dorsolateral prefrontal cortex in bimodal divided attention: Two transcranial magnetic stimulation studies. *Journal of Cognitive Neuroscience*, *19*, pp. 907-920.

Jurgens U. (2002). Neural pathways underlying vocal control. *Neuroscience Biobehavioral Reviews*, *26*, pp. 235-258.

Kleber B., Birbaumer N., Veit R., *et al.* (2007). Overt and imagined singing of an Italian aria. *Neuroimage*. *36*, pp. 889-900.

Koeneke S., Lutz K., Wustenberg T., & Jancke L. (2004). Long-term training affects cerebellar processing in skilled keyboard players. *Neuroreport*, *15*, pp. 1279-1282.

Lotze M., Scheler G., Tan H. R., *et al.* (2003). The musician's brain: Functional imaging of amateurs and professionals during performance and imagery. *Neuroimage*, *20*, pp. 1817-1829.

Lotze M., Seggewies G., Erb M., *et al.* (2000). The representation of articulation in the primary sensorimotor cortex. *Neuroreport*, *11*, pp. 2985-2989.

Mitchell T. V., Morey R. A., Inan S., and Belger A. (2005). Functional magnetic resonance imaging measure of automatic and controlled auditory processing. *Neuroreport*, *16*, pp. 457-461.

Murbe D., Pabst F., Hofmann G., and Sundberg J. (2002). Significance of auditory and kinesthetic feedback to singers' pitch control. *Journal of Voice*, *16*, pp. 44-51.

Nakazawa K., Shiba K., Satoh I., *et al.* (1997). Role of pulmonary afferent inputs in vocal on-switch in the cat. *Neuroscience Research*, *29*, pp. 49-54.

Packard M. G. and Knowlton B. J. (2002). Learning and memory functions of the Basal Ganglia. *Annual Review of Neuroscience*, *25*, pp. 563-593.

Pochon J. B., Levy R., Poline J. B., *et al.* (2001). The role of dorsolateral prefrontal cortex in the preparation of forthcoming actions: An fMRI study. *Cerebral Cortex*, *11*, pp. 260-266.

Prosek R. A. (1975). Intraoral air pressure as a feedback cue in consonant production. *Journal of Speech and Hearing Research*, *18*, pp. 133-147.

Rushworth M. F., Johansen-Berg H., Gobel S. M., and Devlin J. T. (2003). The left parietal and premotor cortices: Motor attention and selection. *Neuroimage*, *20* (supplement 1), pp. s89-100.

Shiba K., Yoshida K., and Miura T. (1995). Functional roles of the superior laryngeal nerve afferents in electrically induced vocalization in anesthetized cats. *Neuroscience Research*, *22*, pp. 23-30.

Soros P., Marmurek J., Tam F., *et al.* (2007). Functional MRI of working memory and selective attention in vibrotactile frequency discrimination. *BMC Neuroscience*, *8*, p. 48.

Sundberg J. (1974). Articulatory interpretation of the "singing formant." *Journal of the Acoustical Society of America*, *5*, pp. 838-844.

Watanabe J., Sugiura M., Miura N., *et al.* (2004). The human parietal cortex is involved in spatial processing of tongue movement: An fMRI study. *Neuroimage*, *21*, pp. 1289-1299.

Zarate J. M. and Zatorre R. J. (2005). Neural substrates governing audiovocal integration for vocal pitch regulation in singing. *Annals of the New York Academy of Sciences*, *1060*, pp. 404-408.

Zatorre R. J. (2001). Neural specializations for tonal processing. *Annals of the New York Academy of Sciences*, *930*, pp. 193-210.

Zatorre R. J., Chen J. L., and Penhune V. B. (2007). When the brain plays music: Auditory-motor interactions in music perception and production. *Nature Reviews*, *8*, pp. 547-558.

Thematic session: Performance analysis III

The timbre vocabulary of professional female jazz vocalists

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Female jazz singers have a large common vocabulary of timbre descriptors that indexes their practically oriented timbral knowledge. We aimed to explore and document that vocabulary by constructing an inventory of timbre descriptors and their physiological or technical correlates. A vocabulary of some 250 terms with definitions, synonyms, and antonyms was assembled from transcriptions of lessons and interviews with six professional jazz singer-teachers. The vocabulary includes such diverse terms as *Mickey Mouse, instrumental, natural, nasty, compact,* and *suspended.* Almost the same vocabulary was used to describe the vocal quality of commercially available recordings. During lessons, timbre descriptors tended to be less important than advice on style, breathing technique, and interpretation. Teachers used their timbral vocabulary intuitively and were often surprised when confronted with it in an interview. They used timbral descriptors to achieve interpretive goals, even if they did not fully understand the physics and physiology (e.g. ideas about voice "placement"). The results highlight musically important aspects of vocal timbre that are worthy of more detailed gestural and acoustical investigation.

Keywords: timbre; vocabulary; female jazz vocalists; teaching

Our research focuses on timbre descriptors used by professional female jazz vocalists. Timbre is at least as central for performance and pedagogy in voice as for other musical instruments. A sizeable vocabulary of timbre descriptors is necessary to help a student to understand the timbral possibilities of his or her instrument and to achieve specific timbral goals. To our knowledge, the diverse and colorful timbral vocabulary of jazz singers has never been the subject of systematic investigation.

Individual differences in vocal timbre depend in part on physiological differences in the vocal folds and vocal tract (Mathelitsch and Friedrich 2000). They also depend on singing style. In the jazz tradition, singers are encouraged to develop an individual timbre that reflects their vocal personality. The widespread use of microphones makes it easier for jazz singers than for "classical" singers of opera and lied to develop "natural" timbres and phrasings that are similar to that of the speaking voice (Ferstl-Pilaj *et al.* 2005). Especially the female voice with its special singing traditions (e.g. belting) has been standing in the center of research in the last years (Miller 2000). In recent research on the timbral vocabulary of pianists and guitarists, Traube collaborated with performers to explore and document their collective knowledge base (Traube and Depalle 2004, Bellemare and Traube 2005). They considered gestural timbre descriptors as part of the feedback loop between hearing and motor control of performer or teacher, related timbre descriptors to speech sounds and a musician's ability to "speak" through the instrument, organized timbre descriptors in a multidimensional space, and related timbre descriptors to performance gestures and the acoustical signal.

In our exploration and documentation of the timbral language of female jazz vocalists, we adopted a similar approach. We aimed to construct an inventory of timbre descriptors and their technical, physiological, and cultural correlates as part of a broader documentation of singers' practical knowledge about sound and of the acquisition and sharing of that knowledge in the oral tradition of vocal teaching.

METHOD

Participants and materials

Participants were six professional female jazz vocalists who were teaching at high school, undergraduate level at music schools in Graz, or the Kunst-universität Graz. The age of the teachers ranged from 25-46 years (mean=35). Lessons were recorded on a Handycam. All participating students were female and had been singing jazz for at least two years.

Procedure

We first asked six female jazz singers and their teachers if they would agree to being videotaped while teaching. We informed them that the study was about jazz singing and its pedagogy. The teachers were unaware that we intended specifically to study the role of timbre in their teaching and the specific words and expressions that they use while teaching. All of them consented. The students sometimes felt uncomfortable with the situation, and we once stopped recording at the student's request.

All teaching was in the German language, but teachers occasionally used English terms, since English is regarded as the international language of jazz and the texts of all songs were in English. The videos were not transcribed in full. Instead, we noted all words that directly or indirectly describe timbre, and transcribed the context in which they occurred. The list of timbral descriptors used by each individual teacher was presented back to the same teacher during a short interview. She was then asked to give synonyms and antonyms of each word in the list, to sing an example of each, to explain how each is produced, and to name jazz singers who produce that timbre. The interviews were transcribed in full and data was obtained from all teachers (see Table 1). We also asked teachers to describe the vocal quality of excerpts from contrasting commercial recordings of female jazz vocalists. The recordings were chosen to cover the greatest possible variety of vocal qualities. There were fifteen examples, each lasting 15 seconds. They were played to each participant in a different random order. Any timbral descriptors used during these descriptions that had not previously been used were entered into the table.

After we had collected about 200 words, we contacted the participants to consider the words again. Each participant was presented with the words they had used themselves (about 15 words), plus 15 words chosen randomly from the words used by other singers. Participants were first asked to give descriptions, synonyms, and antonyms, and were then asked whether each word primarily described sound, technique, or expression. At the end, we had an inventory with 250 words.

RESULTS

Table 1 is an excerpt from our original table of 80 words used to describe specific vocal qualities during lessons. Since the teachers spoke more about technique than timbre, many timbral descriptors refer to the corresponding technique. For example, some participants repeatedly used the terms "open," "pressed" versus "relaxed," and support.

Table 2 is an excerpt from the larger table that we compiled after the interviews. The complete table includes all timbral descriptors used in teaching or interviews, definitions, and information about who used the word in which part of our study (1=videoed lesson, 2=interview, 3=description of recordings).

Table 1. Examples of timbre descriptors used in teaching.

German term	*English translation*	*Participant*
angenehm	pleasant	P1, P2
Anker	anchor	P2
aufmachen	open	P3, P5
ausweichen	avoiding	P6
beweglich	flexible	P5
Biss, reinbeißen	bite	P1, P6
brav	good, well behaved	P6
breit	wide	P5, P6
cool	cool	P6
dezent	discreet	P2

Table 2. Examples of timbre descriptors used in teaching and interviews.

German term	*Our translation*	*Definition based on interviews*	*Synonyms*	*Antonyms*	*Participants*
frei	free	if the vocal tract is open, it sounds free	round, easy, without cracking, effortless	tense, uptight, pressed, cramped	1: P2, P5 2: P1, P2, P5 3: P1
hauchig	breathy	light vocalization, larynx rises, vocal cords separate, the sound becomes airy and somehow pressed.	airy, smoky		1: P3 2: P1, P3, P6 3: P2, P3, P6
natürlich	natural	from the speaking voice		classical, forced	1: P1, P2 2: P1, P4, P6 3: P5

Finally, we documented words used to describe the vocal qualities of commercial jazz recordings. Table 3 shows some of the words which were used to describe one of the 15-second excerpts.

During lessons, timbre descriptors tended to be less important than points of style, breathing technique, and interpretation. The teachers used their timbral vocabulary intuitively and were often surprised when confronted with it in an interview. They sometimes doubted that they had used those specific words. It was evidently unusual for most of them to analyze their own timbral vocabulary.

Table 3. Words used to describe the timbre of Lisa Bassenger singing "I just can't get you out of my head" (Lisa Bessenger Trio, *A Sigh a Song*, Minor Records, 2002).

Term in German	*Our Translation*	*Participant*
anrüchig	seedy	P1
breit	wide	P6
freundlich	friendly	P1
gesprochen	spoken	P6
hauchig	breathy	P6
hell	bright	P1, P6
jugendlich	youthful	P1
jung	young	P1
Knacken	crack	P1
laid back	laid back	P2
leiernd	droning	P2

When describing the vocal quality of the recordings, the teachers used a large timbral vocabulary. Different teachers did not always use the same words for describing a sound, but they often described the sound in a similar way. For example, the term "girlish" could be understood as an umbrella term for: sexy, fidgety, friendly, dingy, youthful, airy, natural, shy, etc.

It was not always possible to clearly separate physiologically from perceptually oriented descriptors. For instance, "open" refers both to vocal tract position and articulation (open vowels) and the sound itself (open sound).

DISCUSSION

Female jazz singers seem to have a fairly small common vocabulary of timbre descriptors that indexes their practically oriented timbral knowledge. Teachers were always able to define or explain the timbral terms used by other teachers, even if they had not used those terms themselves, and the different definitions were consistent with each other. Every second word in our list was used by at least two participants. The words "open," "bright," "classical," "airy," and "vibrato" were used by all teachers and hence are the most often named timbre descriptors. Thirty-four words in our list were used by at least four of the six teachers and in this sense may be regarded as the common vocabulary.

We believe that this research has interesting implications for vocal pedagogy. It may help teachers to become more aware of their timbral vocabulary and use terms more precisely and consistently. The results also highlight musically important aspects of vocal timbre that are worthy of detailed gestural and acoustical investigation.

Acknowledgments

We thank the six participants and their students for their support and interest, members of Richard Parncutt's research colloquium at the University of Graz for several useful discussions, and Manuela Marin and Margaret Painsi for advice on methodology. Further, we wish to thank Gerda Strobl for reading and useful comments.

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References

Bellemare M. and Traube C. (2005). Verbal description of piano timbre: Exploring performer-dependent dimensions. Paper presented at the *Conference on Interdisciplinary Musicology (CIM05)*, Montréal, Canada.

Ferstl-Pilaj J., Friedrich G., Mathelitsch L., *et al.* (2005). *Jazz-Gesang versus Klassik: Cross-over-training mittels Computer-Feedback*. Graz, Austria: Akademische Druck und Verlagsanstalt.

Mathelitsch L. and Friedrich G. (2000). *Die Stimme*. Vienna: öbv & htp.

Miller D. G. (2000). *Registers in Singing: Empirical and Systematic Studies in the Theory of the Singing Voice*. Groningen, The Netherlends: University of Groningen.

Traube C. and Depalle P. (2004). Phonetic gestures underlying guitar timbre description. In S. D. Lipscomb *et al.* (eds.), *Proceedings of 8th International Conference on Music Perception and Cognition* (pp. 658-661), Evanston, Illinois, USA: Northwestern University.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Authenticity in the twentieth century: Listening to composer's own recordings

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The aim of this paper is to question the concept of both "authenticity" and "historically informed performance" by means of analyzing recordings of music composed in the twentieth century. Moreover, it attempts to shed light on the use of historical recordings for performance practice. Examples with recorded music by Grieg, Webern, Shostakovich, and Messiaen were analyzed, forming the basis for ascertaining how close from the composer's intentions one might get. Recordings by several performers were chosen following a hierarchic model of "authority" by Robert Philip. The results indicated that the biggest differences between the composer's interpretation and the interpretations by other performers occur when modern techniques of composition were used by composers whose interpretative style was rooted in the romantic tradition of performance. Generation gaps between performers were also observed as far as expressive deviation was concerned. It is concluded that both musical and cultural background play a fundamental role in the way works are performed and surpass the realms in which musical analysis can have an impact in performance practice.

Keywords: performance; interpretation; analysis; recordings; authenticity

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International Symposium on Performance Science
ISBN 978-90-9022484-8

A prototype system for rule-based expressive modifications of audio recordings

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A prototype system is described that aims to modify a musical recording in an expressive way using a set of performance rules controlling tempo, sound level, and articulation. The audio signal is aligned with an enhanced score file containing performance rules information. A time-frequency transformation is applied, and the peaks in the spectrogram, representing the harmonics of each tone, are tracked and associated with the corresponding note in the score. New values for tempo, note lengths, and sound levels are computed based on rules and user decisions. The spectrogram is modified by adding, subtracting, and scaling spectral peaks to change the original tone's length and sound level. For tempo variations, a time scale modification algorithm is integrated in the time domain re-synthesis process. The prototype is developed in Matlab. An intuitive graphical user interface (GUI) is provided that allows the user to choose parameters, listen, and visualize the audio signals involved, as well as perform the modifications. Experiments have been performed on monophonic and simple polyphonic recordings of classical music for piano and guitar.

Keywords: automatic music performance; performance rules; musical expression; emotions; audio signal processing

A music performance represents the interpretation that a musician (or a computer in our case) gives to a score. To obtain different performances, the musician often follows some principles related to structural features of the score (e.g. musical phrases, harmony, melody). The KTH rules system for musical performance (Friberg *et al.* 2006) models such principles in a quantitative way in order to control three main musical parameters: tempo, articulation, and sound level. The rules are used to play back MIDI files expressively (Friberg 2006). The result sounds often unnatural, mostly because of the quality of the synthesizer.

We propose a different approach to automatic music performance in order to obtain a more realistic result: directly modify a recorded human performance. Previous attempts to make automatic expressive modifications of tempo have been suggested by, for example, Gouyon *et al.* (2003) and Janer *et al.* (2006). Interactive virtual conducting systems are other examples of expressive tempo and sound level modifications (Borchers *et al.* 2004). In this case the modifications are not automatic but controlled by the user. In our system, the modifications of the audio signal are done on a note basis, allowing also changes of the length of single tones (articulation).

We also take into account timbre variations of acoustic instruments when changing the sound level (Luce 1975). The whole process should avoid noticeable artifacts and work on monophonic and polyphonic recordings.

METHOD

The system can be divided into three main sections as shown in Figure 1. In section (a), the audio signal is aligned with the score file, transformed into the time-frequency domain, and analyzed. In section (b), the modifications on the spectrogram, as well as the synthesis of the modified time domain signal, are performed. Note lengths, sound level, and tempo are computed in section (c) using rules values and inputs from the user.

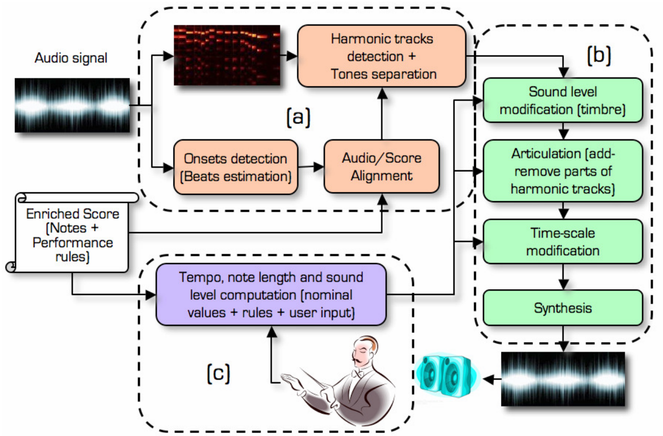

Figure 1. Schematic representation of the system. (See full color version at www.performancescience.org.)

Level score alignment and signal analysis

In order to modify the performance on a note basis, each tone needs to be separated from the rest of the signal. In polyphonic recordings, tones can also overlap. A tone produced by an acoustic instrument is usually harmonic, with a large number of partials. To modify the single tone in the time-frequency domain, the partials need to be associated with their corresponding fundamental and note in the score.

The system uses an enhanced score file containing performance rules values. The score notes are also used in combination with the spectrogram to analyze the audio signal in order to separate the harmonic components of each tone. The score is aligned with the audio signal using tone onset positions, which can be extracted automatically (using a simple algorithm based on an edge detection filter), defined by hand or a combination of the two.

The signal is divided into overlapping time windows and transformed into a time-frequency representation using the method proposed by Ferreira and Sinha (2005). This method allows for accurate estimation of the frequency of spectral peaks. For each time window, the expected tone fundamental frequency and its partials are computed according to the notes in the score. The peaks in the spectrogram are detected and associated with the corresponding note in the score.

Modifications and synthesis

The KTH rule system concentrates on the modification of tempo, sound level, and articulation; three acoustic parameters that have been found to be crucial for performance expression (Juslin 2000). In our prototype, the modifications are performed in the frequency domain using an analysis-synthesis approach in this order: articulation, sound level, and tempo.

Articulation is changed by lengthening (*staccato* to *legato*) or shortening (*legato* to *staccato*) the harmonic tracks corresponding to the tone. Using Ferreira's (2001) method, we interpolate the magnitude of the frequency peak and the two adjacent frequency bins and subtract them. In the same way, we can interpolate the magnitude of new peaks and add them to lengthen a tone.

Acoustic instruments usually sound brighter (e.g. higher partials are present) when played loud compared to when played soft. Therefore, to obtain a realistic sound level modification, the timbre also needs to be changed. Addition and subtraction of partials can be done using the same method applied for articulation. In addition, knowledge about the original sound level of each tone is needed in order to apply the correct amplitude scaling. Measurement of the single tone level in a polyphonic recording is a complex problem that we have not yet solved. For this reason, in the prototype system, sound level modifications are currently not performed.

The modification of tempo is integrated in the synthesis algorithm. As mentioned earlier, the transformation to time-frequency domain is performed by first dividing the audio signal into overlapping time windows, separated by hop-size R_a. A common way to do time scale modifications (Laroche and Dolson 1999) is to modify the synthesis hop-size, R_s, so that the reconstructed time windows are more or less largely spaced (time scale expansion or compression). When R_s becomes too small or too large, audible artifacts are introduced. To avoid this problem, we either discard some frames or use the same frame twice. This approach has the side effect that it may also smear sharp tone attacks. By using R_s=R_a within tone attacks, we avoid this effect.

A major drawback of direct modifications of the spectrogram is phase incoherence, which introduces artifacts known as "phasiness" or "loss of presence." The inverse transformation to a time domain signal requires both magnitude (spectrogram) and phase responses. Since only the magnitude is modified, the combination with the original phase response usually does not produce a real signal. Solutions have been proposed that try to correct the phase response to maintain coherence (Laroche and Dolson 1999) for time scale modifications. In our case, the problem is more complicated as we need to keep track of additions and subtractions of frequency peaks. For this reason, we decided to discard the original phase information and reconstruct the time domain signal from the magnitude only using the Real Time Iterative Spectrogram Inversion (RTISI) method (Beauregard *et al.* 2005). This algorithm also smears sharp tone onsets. Since we do not modify the magnitude response of the time frames containing onset data, for these frames we use the original phase response to prevent smearing, while for modified frames we use RTISI.

Performance values computation

The modifications of the performance are based on a new value of sound level and length for each note, as well as a series of tempo values (usually one for each Inter Onset Interval). These values are the sum of the nominal value from the score and a delta value obtained from a weighted sum of the values of the rules. The weights are individually defined by the user or saved in default sets (e.g. happy, sad, angry, tender performance). There are 19 rules in the system and each rule influences one or more of the acoustic parameters. For a more detailed explanation, refer to Friberg (2006).

RESULTS

The system described above, with some limitations, has been implemented using Matlab. The user is provided with a simple graphical user interface (GUI) to load audio files and score files. The waveform is visualized together with tone onset points. These points can be detected automatically and manually corrected in case of errors in the detection. The user can choose some analysis parameters such as window and hop size. The user controls the overall tempo and performance parameters from the default sets or by using sliders for each rule. Before performing the synthesis, it is possible to choose whether or not to modify articulation. The sound level modification has not yet been implemented.

A few experiments using monophonic recordings of a theme from Haydn's *F Major Quartet* (Op. 74, No. 2), played with piano and guitar, showed good results for tempo modifications (sharp attacks are preserved). For articulation, a sort of reverberation effect is introduced in the silenced parts when the analysis is not able to extract all the frequency peaks. In the case of polyphonic recordings, the tempo modification does not introduce extreme artifacts, but the articulation is rather noisy, as the separation of partials becomes more complex with overlapping tones.

DISCUSSION

In this paper, we presented a system that aims to modify a musical recording (tempo, sound level, and articulation of each single tone) in order to obtain an automatic performance comparable to a human performance in terms of expressivity and sound quality. The main problem is the separation of each single tone from the rest of the recording. We use a time-frequency representation and extract harmonic tracks corresponding to each tone. This is not yet reliable enough, and we are investigating how to improve the tone separation. The articulation of single notes strongly depends on the quality of the separation. Another open problem is that of measuring the sound level of the single tone in order to modify it consistently. A more reliable onset detection algorithm is also needed.

Possible applications for this system are in music cognition studies, where stimuli are usually artificial sounding MIDI files. Another example is the implementation of an advanced home conducting system that can work with any available recording.

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References

Borchers J., Lee E., and Samminger W. (2004). Personal orchestra: A real-time audio/video system for interactive conducting. *Multimedia Systems*, *9*, pp. 458-465.

Beauregard G. T., Zhu X., and Wyse L. (2005). An efficient algorithm for real-time spectrogram inversion. *Proceedings of the 8th International Conference on Digital Audio Effects* (pp. 116-118). Madrid, Spain: Universitad Politécnica de Madrid

Ferreira A. J. S. (2001). Combined spectral envelope normalization and subtraction of sinusoidal components in the ODFT and MDCT frequency domains. *Proceedings of the 2001 IEEE Workshop in Applications of Signal Processing in Audio and Acoustics* (pp. 51-54). New Paltz, New York, USA: IEEE.

Ferreira A. J. S. and Sinha E. (2005). Accurate and robust frequency estimation in the ODFT domain. *Proceedings of the 2005 IEEE Workshop in Applications of Signal Processing in Audio and Acoustics* (203-206). New Paltz, New York, USA: IEEE.

Friberg A. (2006). pDM: An expressive sequencer with real-time control of the KTH music performance rules. *Computer Music Journal, 30*, pp. 37-48.

Friberg A., Bresin R., and Sundberg J. (2006). Overview of the KTH rule system for music performance. *Advances in Cognitive Psychology, 2*, pp. 145-161.

Gouyon F., Fabig L., and Bonada J. (2003). Rhythmic expressiveness transformations of audio recordings: Swing modifications. *Proceedings of the International Conference on Digital Audio Effects (DAFX03)*. London: Queen Mary, University of London.

Janer J., Bonada J., and Jorda S. (2006). Groovator: An implementation of real-time rhythm transformations. *Proceedings of the 121st Convention of the Audio Engineering Society*. San Francisco, California, USA: AES.

Juslin P. N. (2000). Cue utilization in communication of emotion in music performance: Relating performance to perception. *Journal of Experimental Psychology: Human Perception and Performance, 26*, pp. 1797-1813.

Laroche J. and Dolson M. (1999). Improved Phase Vocoder. Time-scale modification of audio. *IEEE Transactions on Speech and Audio signal processing, 7*, pp. 323-332.

Luce D. A. (1975). Dynamic spectrum changes of orchestral instruments. *Journal of the Audio Engineering Society*, *23*, pp. 565-568.

Thematic session: Physicality of performance

International Symposium on Performance Science
ISBN 978-90-9022484-8

Biographical predictors of music-related motor skills in children pianists

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This study aimed to identify biographical predictors of children pianists' motor skills in a relevant musical context. Motor skills at the piano were assessed in 30 piano-playing children by testing temporal evenness in standardized scale playing which is a basic element of piano technique. Questionnaires were used to collect detailed information regarding the practice habits and other biographical factors. Associations between performance values and variables from the questionnaire were investigated by multiple regression analysis. Besides the duration of piano education and the frequency of technical exercise, motivational factors and parental supervision predicted children pianists' motor skills in the selected motor task, i.e. in a relevant musical context.

Keywords: sensorimotor learning; motor skills; practice; music performance; piano

Performing instrumental music is one of the most complex of human accomplishments. Musicians' motor coordination is highly complex and takes place at an extremely high level of spatiotemporal accuracy. Successful strategies for the acquisition of motor coordination and musical abilities required for this challenging task are of interest to both instrumental teachers and expertise researchers.

A number of publications have reported on research that related biographical variables with musical performance achievement (for a review, see McPherson 2006). So far, little attention has been paid to the acquisition of motor skills in children musicians and, in particular, of motor performance in relevant musical tasks. Objective quantification of motor performance in a relevant musical task was previously carried out in professional pianists while they were playing standardized C major scales (Jabusch 2006). Scale playing is one fundamental aspect of piano technique. In C major scales played by professional pianists, a high degree of temporal evenness in the inter-onset intervals was revealed using a Musical Instrument Digital Interface (MIDI)-based analysis method. This method has been shown to be a valid and reliable tool to investigate temporal evenness in scale playing of pianists (Jabusch *et al.* 2004).

In the present study, we examined children pianists' motor performance as measured by temporal evenness in scale playing, and investigated biographical factors and their association with motor performance. These biographical factors included the child's history of practicing and learning the piano, information regarding their everyday musical environment, their attitudes towards music and practice, their subject preferences at school, and the extent to which their parents supervised their practice.

METHOD

Participants

The subjects for the study comprised 30 school-aged children who were taking piano lessons at the time of the study (22 girls and 8 boys, aged between 8 and 17 years old, median age 13). Of the participants, 26 took their piano lessons at the Hanover music school, while four subjects were taking lessons at the Hanover University of Music and Drama. All subjects had been learning the piano for at least nine months prior to the study. The only inclusion criterion was the ability to play C major scales with both hands. Informed consent was obtained by all participants and their parents.

Materials

A questionnaire was developed that sought information on the general pianistic and musical history of the subject, focusing on details of their practice amount and content (e.g. retrospective assessment of practice quantity, repertoire, frequency of practicing technical exercises), details of piano lessons (e.g. content of lessons, number of piano teachers in the past), their attitudes towards music and practice, and their involvement in other musical activities. Subjects were asked about musical activities in the family and how often a parent supervised them during their practice at home. A series of questions asked the children to rate their enjoyment of five different school subjects (music, mathematics, visual arts, sport, and language). Subjective ratings (e.g. of frequencies or of enjoyment) were encoded on corresponding 5-point scales. The questionnaire was completed with the assistance of a single researcher who was available to give clarifications when uncertainties arose in the questions. Parents of the younger subjects were asked to assist in the answering of questions.

Procedure

The procedure of scale playing and analysis of temporal evenness was performed according to a protocol published previously (Jabusch *et al.* 2004). Scales were performed on a digital piano that was connected to a computer. For the test, sequences of 10 to 15 C major scales were played over two octaves (range: C3-C5) in both directions, inward and outward, with each hand separately. Participants were asked to play in legato-style. Fingering was according to the regular C major fingering. The tempo was standardized and paced by a metronome (80 beats per minute, two notes per beat). Inter-onset intervals for all individual notes of the scales were analyzed using a researcher-developed software. Scale analysis was performed for each hand and in both directions separately. Mean standard deviations of inter-onset intervals (msdIOI) were calculated for all scales of each hand and playing direction. The msdIOI parameter was previously shown to be a reliable indicator of temporal evenness in pianists' scale playing (Jabusch *et al.* 2004). The median of the msdIOI values of both hands and playing directions (MIOI) indicated the overall temporal unevenness of note onsets for each participant.

Pearson correlations were calculated to detect associations between performance values and variables from the questionnaire. Stepwise multiple regression analyses were used to assess predictability of performance results. The two-tailed level of statistical significance was set at $p<0.05$.

RESULTS

Participants began to play piano between the age of 5 and 12 years (median=7 years) and the duration of their piano education was between 9 months and 12 years (median=5 years). The median daily practice time was 0.5 hours (range=0.2-3.5), and the median total life practice time was 559 hours (range=88-8700).

Results from the questionnaire regarding participants' attitudes towards music, performing, practice, and technical exercises, as well as the frequency of parental supervision and technical practice are displayed in Figure 1.

In the performance test, all children were able to play the scales according to the protocol. MIOI indicated the overall temporal unevenness of note onsets for each participant. A *low* score for MIOI denotes a *low* level of un-

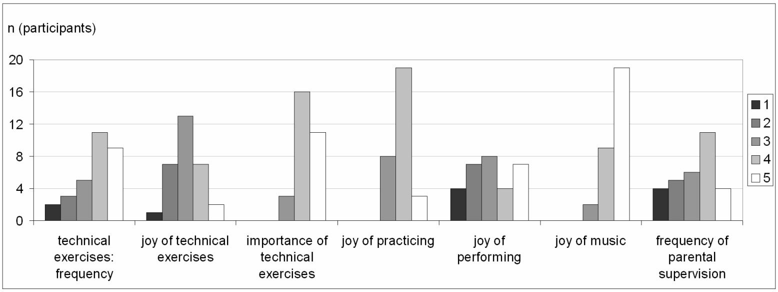

Figure 1. Distributions of results from the questionnaire. Frequencies are coded as 1= never, 2=rarely, 3=sometimes, 4=often, and 5=very often. In the displayed enjoyment rating scales, 1 represented a negative enjoyment rating and 5 a positive enjoyment rating. In the rating of importance, 1 represented a low importance and 5 a high importance.

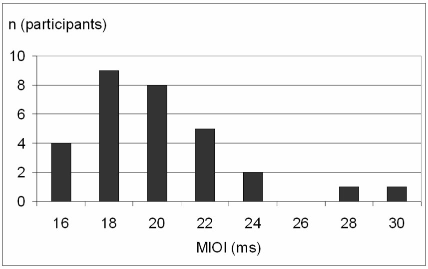

Figure 2. Distribution of motor performance results. MIOI values indicate the individual overall temporal unevenness of note onsets in standardized scale playing for each participant.

evenness in the scales (high temporal onset precision), while a *high* score for MIOI denotes a *high* level of unevenness (low temporal onset precision). Distribution of performance results is given in Figure 2.

A correlation was observed between the motor performance values MIOI and the daily practice time (r=-0.45, p<0.05), the total life practice time (r=-0.46, p<0.05) and the duration of piano education (r=-0.41, p<0.05). Stepwise multiple regression analysis revealed a model predicting 68% of the variance of MIOI values, with the following six items of the questionnaire as predictors: duration of piano education (30%), enjoyment of practice (10%), frequency of practicing technical exercises (9%), enjoyment of the subject

Table 1. Information on the model revealed by stepwise multiple regression analysis.

Regression equation	R^2	R^2 *adjusted*
MIOI = 44 - 0.97 (years piano) - 1.6 (joy practice) - 1.2 (frequency exercises) + 2.9 (joy art_{rel}) - 0.93 (parental supervision) - 1.6 (joy music)	0.76	0.68

Key. MIOI=individual overall temporal unevenness of note onsets (ms); years piano: duration of piano education (years); joy practice=enjoyment rating of practice (high value represented a positive enjoyment rating); frequency exercises=frequency of practicing technical exercises (high value represented a high frequency); joy art_{rel}=enjoyment rating of visual arts at school, relative to enjoyment ratings of other subjects (low value represented a high enjoyment); parental supervision=frequency of parental supervision (high value represented a high frequency); joy music=enjoyment rating of music (high value represented a positive enjoyment rating).

visual arts at school (7%), frequency of parentally supervised practice (6 %), and enjoyment of music (6%). Details are given in Table 1.

DISCUSSION

The aim of the study was to identify biographical predictors of children pianists' motor skills in a relevant musical context. According to expectations, variables that determined the amount of time children spent at the instrument (daily practice time, total life practice time, and total years playing the piano) were significantly correlated with temporal fine motor precision. Moreover, the duration of piano education was a predictor for temporal fine motor precision. These findings coincide with the principle suggested by Ericsson *et al.* (1993) proposing 10 years and 10 000 hours of deliberate practice required for the acquisition of expertise. Our results are in keeping with results of various studies that related the number of years of practice with instrumental achievement (e.g. Sloboda and Davidson 1996, McPherson 2005). The frequency of technical practice, a predictor of fine motor precision explaining 8% of the variance in the temporal onset precision, can be classified as one type of deliberate practice according to the definitions described by Ericsson *et al.* (1993). External and internal motivational factors were frequently described as influential factors for musical development. Sloboda and Davidson (1996) emphasized the possibility and necessity of external motivation developing into internal self-motivation by the early teenage years as a prerequisite to sustain the commitment required to persist with musical instrument learning. In the present study, the frequency of parentally supervised practicing represents an external motivational factor that turned out to be a predictor of temporal fine motor precision. The predictors enjoyment of practice, enjoyment of music, and enthusiasm for the subject visual arts at school may represent internal motivational factors not only for making music but additionally for a further artistic disposition. Taken together, predictors of motor skills in children pianists cohered with factors previously found to influence musical achievement at the instrument, even with the focus on a selected motor task in a relevant musical context.

Acknowledgments

The authors would like to express their appreciation to all participating piano students and to the piano faculty of the Musikschule Hannover for their kind support.

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References

Ericsson K. A., Krampe R. T., and Tesch-Römer C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* pp. 363-406.

Jabusch H. C., Vauth H., and Altenmüller E. (2004). Quantification of focal dystonia in pianists using scale analysis. *Movement Disorders, 19*, pp. 171-180.

Jabusch H. C. (2006). Movement analysis in pianists. In E. Altenmüller, J. Kesselring, and M. Wiesendanger (eds.), *Music, Motor Control and the Brain* (pp. 91-108). Oxford: Oxford University Press.

McPherson G. E. (2005). From child to musician: Skill development during the beginning stages of learning an instrument. *Psychology of Music, 33*, pp. 3-35

McPherson G. E. (ed.) (2006). *The Child as Musician: A Handbook of Musical Development*. Oxford: Oxford University Press.

Sloboda J. A. and Davidson J. W. (1996). The young performing musician. In I. Deliège, and J. A. Sloboda (eds.), *Musical Beginnings: The Origins and Development of Musical Competence*. (pp. 171-190). Oxford: Oxford University Press.

International Symposium on Performance Science
ISBN 978-90-9022484-8

The role of the Alexander technique in musical training and performing

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Most students enter music conservatoires with long-standing inappropriate habits in their manner of using themselves in activity. These habits hamper the smooth operation of postural support systems, which are fundamental to all skilled movements. By learning and applying the Alexander technique (AT) individuals are able to avoid unwanted reactions. Performance improves and activities are seemingly effortless. The first scientific study uses a whole body Magnetic Resonance Imaging system (MRI and fMRI) to investigate reorganizations of the structure and function of the human body and, in particular, the brain during Alexander "directing." The second study is of student pianists playing scales. Key velocity and timing data are collected and analyzed to show a significant difference in touch before and after the AT lesson.

Keywords: Alexander technique; musical performance; MRI scanning

During twenty-two years of teaching the Alexander technique (AT) to music students, the first author has observed that most enter music conservatoires with long-standing inappropriate habits in the way they use themselves in daily activities. Maladapted tension patterns hamper the self-regulating neuro-muscular systems for postural support, balance, and coordination. This lowers the individual's ability to perform optimally in whatever he or she is doing.

This paper reports on two different approaches to studying the effects of the AT. The first seeks to provide a scientific description of the systematic approach at the heart of the AT and to obtain measurements of its effects. To achieve this we are using a whole body Magnetic Resonance Imaging (MRI) system to measure the reorganization of the structure and function of the human body and, in particular, the brain that occurs during a series of AT lessons. The second uses a MIDI keyboard to investigate the effect of Alexander lessons on pianists' accuracy in playing musical scales.

Many difficulties experienced in "how to" learning are caused by the individual's inadvertent interference with underlying mechanisms that are vital for smooth coordinated activity, including breathing function. It is clearly observable that in normal, healthy conditions all vertebrates tend to lengthen head-to-tail in activity (Magnus 1924; reported by Charles Sherrington in his anniversary addresses to the Royal Society, London, 1924, 1925). Integrated activity in the back, neck, and shoulders is fundamental to skilful arm and hand movements (Ballard 1996, p. 42) and breathing and vocal functioning (Davies and Jahn 1998). Before considering the specifics of a task, therefore, it is reasonable to ensure the best general conditions of psychophysical functioning (Alexander 2000, p. 8).

For we humans, *balance* is a prerequisite for every activity carried out during waking hours (Davies 1985, cited in Trew and Everett 2001). Routine stiffening and bracing interferes with the appropriate automatic postural adjustments. In particular, most people tend to overuse the muscles of the upper torso, which disrupts its concerted activity (Alexander 1996, 2004). By learning how to prevent one's too quick and unthinking reactions it can be understood in practice how satisfactory working of the postural mechanisms can be restored (Alexander 2004).

In time, with better use and functioning, old feelings are outmoded. The individual develops a more reliable "[sense] register of the due and proper amount of so-called 'muscular tension' necessary at a given time" (Alexander 2004, p. 109) and the "right degree of action" and "co-ordinative management" (Alexander 2000, p. 119). A precise description of what is involved is impossible to convey in words alone. When done as intended however, it ensures a satisfactory standard of general functioning on which to build and develop a reliable musical technique. Activities are more skilful, controlled, and seemingly effortless.

MRI STUDIES

The first scientific study investigates the possibility of using Magnetic Resonance Imaging to study the AT and to measure its effects and, in particular, to test a hypothesis regarding brain function. If we perform an fMRI study in which an AT teacher is attending (proprioceptively) to the "directions" being given by a second AT teacher we will observe activation of neurons in the brain stem or spinal cord.

Body structure and function

With regard to studying the well-known effects of the AT on body structure, using MRI it is possible to depict the musculoskeletal system of a living human subject in exquisite detail. Studies of body function may also be performed including voice production. It is intended to report on this at a later stage.

Brain structure and function

In a feasibility study, we used fMRI to study the effect of an AT teacher giving himself "directions" whilst his hands were in contact with a second teacher who lay quietly attentive within the MR system.

The brain images were statistically analysed using SPM99 (Functional Imaging Laboratory, Queens Square, London) and indicate significantly greater neural activity in the brain stem of the "receiver" when he is experiencing the effects of the other teacher's directed thinking. The result is shown in the right hand panel of Figure 1.

This finding of brain stem activation is potentially important since it is likely that the ability of the AT to access the brain stem is one of the key reasons why it is effective in altering automatic postural coordination and "central set" (Cacciatore 2005).

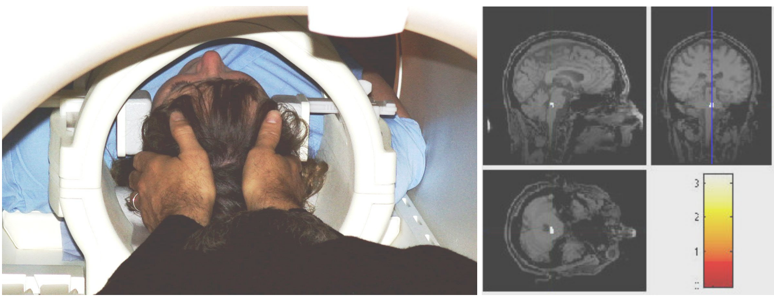

Figure 1. MRI set-up and brain images collected as part of the study. (See full color version at www.performancescience.org.)

MEASURING AND IMPROVING PERFORMANCE

Several recent studies have been carried out by masters and final year bachelors students of acoustics at the University of Salford, in which pianists were recorded playing scales before and after some form of intervention. The aim of two recent studies was to quantify the difference in musical skill before and after an AT lesson (Fletcher 2005, Bennett and Morris 2006).

In the most recent study, music students were recorded playing scales immediately before and after an AT lesson. The students from the Royal Northern College of Music were monitored for between two and five sessions. An electric piano had a MIDI output connected to a computer so that note timing and key velocity data could be easily downloaded and stored for later analysis. Students were asked to play four octave scales, hands separately, ascending and descending, three times in succession to a metronome. There are clear advantages in using scales (Jabusch *et al.* 2004) rather than “real” music where expressiveness is involved, which is much harder to quantify. The hypothesis to be tested was whether there was a difference in the evenness of scales played before and after the lesson.

We looked initially at the time between notes. Later it was shown that key velocity data rather than note timing gave more significant results. Key velocity is the speed at which the key hits the stop, so is related to touch. The variability in touch for one of the participants is shown in Figure 2. This participant attended five sessions. The data in Figure 2 are averaged over these five sessions, and the error bars show how much variation there was from one session to the next (±1 SD between sessions). It is seen that for every scale, except F harmonic minor, the variability of key velocity reduced after the AT lesson. Similar results were obtained for the other three participants.

Since in every case the variability decreased, it is reasonable to call this an improvement, the significance of which was confirmed using a student *t*-test. The results of the *t*-test for participant 1 are summarized in Table 1 and indicate that the improvement for the first three scales is statistically significant. Again, similar results were obtained for other subjects. We can therefore conclude that evenness of touch was significantly improved after the AT lesson.

As always, we need to be careful about exactly what has been demonstrated, but we have now reached the stage where we are satisfied that the scale analysis has been sufficiently refined to demonstrate improvements in musical technique, and we can consider further improvements to the methodology.

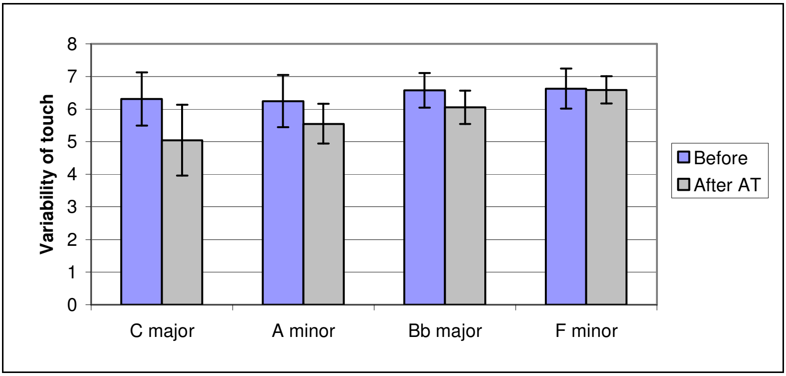

Figure 2. Variability of touch (key velocity) for participant 1 before and after AT lessons. Data are averaged over five sessions, and error bars give ±1 SD over these sessions. (See full color version at www.performancescience.org.)

Table 1. Student *t*-test significance for participant 1. The numbers indicate the probability that the improvement after AT could have occurred by chance alone, e.g. for Bb major there is only a 2% probability that the improvement is by chance.

C major	*A minor*	*Bb Major*	*F minor*
0.42%	2.07%	1.97%	44.56%

The scientific study of the AT is likely to lead to our obtaining a more full understanding of how the technique works, which will surely assist the teacher to teach and the pupil to learn more efficiently, catalyzing the further development of the AT and lead to the development of methods for measuring and monitoring its efficacy.

Acknowledgments

Thanks to Dr. Arshad Zaman and Lisan Ho of MARIARC, Dr. Kathleen Ballard, and Trish Baillie for their assistance. The University of Salford studies were carried out by Christine Bennett, Paula Morris, Neil Fletcher, and Alan Wood. We would like to thank the students at the RNCM who participated voluntarily in the study.

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References

Alexander F. M. (1996). *Man's Supreme Inheritance*. London: Mouritz. (Original work published in 1918.)

Alexander F. M. (2004). *Constructive Conscious Control of the Individual*. London: Mouritz. (Original work published in 1923/1924.)

Alexander F. M. (2000). *The Universal Constant in Living*. London: Mouritz. (Original work published in 1941/42.)

Ballard K. (1996). The nature and behaviour of postural support systems and improvement of their performance by a rational approach: The Alexander technique. *Performing Arts Medicine News*, *3*, pp. 41-47.

Cacciatore T. W., Horak F. B., and Henry S. M. (2005). Improvement in automatic postural coordination following Alexander lessons in a person with low back pain. *Physical Therapy, 85*, pp. 565–578.

Calvert C. (2006). *Investigating the Use of the Alexander Technique to Improve Musical Performance*. Unpublished undergraduate dissertation, School of Computing Science and Engineering, University of Salford.

Davies D. G. and Jahn A. J. (1998). *Care of the Professional Voice*. Oxford: Butterworth Heinemann.

Fletcher N (2005). *Improvement in Musical Performance due to Application of Alexander Technique*. Unpublished masters dissertation, School of Computing Science and Engineering, University of Salford.

Jabusch H. C., Vauth H., and Altenmüller E. (2004). Quantification of focal dystonia in pianists using scale analysis. *Movement Disorders, 19*, pp. 171-180.

Morris P. (2006). *Investigating the Use of the Alexander Technique to Improve Musical Performance*. Unpublished undergraduate dissertation, School of Computing Science and Engineering, University of Salford.

Roberts N. (2006). Measurement science and the Alexander technique. Paper presented at the *6th International Conference for Alexander Teachers Working in Music Institutions*, Royal Northern College of Music, Manchester, UK.

Trew M. and Everett T. (eds.) (2001). *Human Movement*. London: Churchill Livingston.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Kinesics analysis in the investigation of the emotion expression in music performance

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This paper discusses body language within musical performance and contributes to a theory of gesture as a practice within musical performance. Based on a point-light technique approach, empirical evidence has shown that the abstract movement of the point lights (resulting from the video recording of a series of facial movements while experienced singers expressed different emotions in singing performance) had sufficient dynamic information to be recognized by an audience according to the emotional intention performed by the singer. It seems, then, that performers, conscious or unconsciously, use physical gestures associated with emotional states and other expressive issues as a basis for shaping musical expression. Ultimately, it is possible to consider that bodily movements may function as indicators of expressive intentions of the performer and, when linked to important music structures, may also be seen as giving musical expression to emotional states presented through the music.

Keywords: music; emotion; performance; gesture; kinesics

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Thematic session: Learning and Teaching II

International Symposium on Performance Science
ISBN 978-90-9022484-8

PGCE music students' perceptions of the benefits of their musical involvement outside of school

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This study aims to assess the perceived impact of PGCE (Post-Graduate Certificate in Education) music students' engagement in music making outside of school. It specifically attempts to uncover teacher trainees' attitudes toward their own music making, what kind of musical activities they are involved in, how they perceive these activities in terms of their value in their lives, their possible impact on the quality of their teaching, and the perceived satisfaction they get from their teaching as a result of their own musical engagement outside of school. Thirty-four music teacher trainees in secondary education were asked to report on the perceived impact that their participation in music making outside school had on their lives during their training and on its expected impact as a qualified music teacher. It was found that being musically involved outside of school has both personal and professional benefits for them: it increases their job satisfaction and helps them become better teachers. They all expressed a desire to be involved in such musical activities as qualified music teachers because they felt that these can help them maintain their enthusiasm, be more confident and motivated, and keep their technique and performance standards at a high level.

Keywords: music teachers; music making; impact of musical activity; job satisfaction; professional development

Following Bransford and Brown's (2000) description, Mills (2004) argues that performer-teachers ["performers for whom instrumental (including vocal) teaching is integral to their professional identity"] are "accomplished novices" rather than "answer-filled experts" who are highly motivated to develop their teaching expertise, learn from their teaching activity, and transfer this knowledge into the performing context to help their further development as performers.

This study seeks to address a related question: do extra-school musical activities of teachers affect their teaching positively? Is there, therefore, a similar but opposite trend in this case?

Recently there has been some recognition in the music teacher education field of the rich professional lives that many music teachers enjoy in their music making and music teaching, and of the effective and satisfying career that this may often lead to. In a national survey carried out in the USA, the National Center for Education Statistics (2002) reports that out of the 453 public elementary music specialists who responded to the survey, 83% had an active performing role as a soloist or with an ensemble.

Bernard's research (2004) sheds some light on how music teachers who are also performing musicians speak about their work in terms of the relationship between these two professional activities. She also argues that, until the beginning of the twenty-first century, the active and diverse musical lives that music teachers often have outside of school were largely ignored in the music education literature, even though many music teachers must have been highly accomplished musicians to get the appropriate music teaching qualification.

Drummond (2001) found that trainee music teachers considered musical enthusiasm to be the most essential quality in a music teacher. How can musical enthusiasm in teaching be developed and maintained? In the same study, extra-curricular, GCSE, and A-level classes were generally approached with higher levels of enthusiasm than non-examination KS3 (Key Stage 3) and KS4 classes. As Drummond (2001) explains, music students and teachers continue to derive the highest satisfaction from those aspects of school life where they had themselves discovered it in their own school days.

When asked to provide their views on music in school, 8-14 year old pupils identified playing instruments as one of their most favorite aspects, in addition to having the opportunity to have contact with "real" professional musicians (Lamont *et al.* 2003). This is an interesting finding that ties in well with the proposed research, which hypothesizes that musically active teachers could themselves provide this kind of "real" professional musician role model to their students.

The main aim of this study is to assess the perceived impact of PGCE music students' engagement in music making outside of school. In particular, it aims to explore their attitudes toward their current and possible future involvement in such musical activities regarding specifically any possible effects these may have on the quality of their teaching and their job satisfaction.

METHOD

Participants

Thirty-four music teacher trainees in secondary education were asked to report on the perceived impact that their participation in music making outside school had on their lives during their training and on its expected impact as a qualified music teacher.

Materials

They were presented with the following questions:

- Are you involved in music making outside school? (Please specify the musical style and genre.)
- What other kinds of musical activities have you been involved in the past?
- Does your musical involvement outside school help you in any way? Personally? Professionally? In what way?
- Does it increase your job satisfaction in any way? How?
- Does it help you become a better teacher? If so, how?
- Do you see yourself continuing to be involved in such musical activities outside school as a qualified music teacher? Do you think it is important or not?

Procedure

The data collected were then analyzed using the software package Atlas.ti. The questionnaires were subject to in-depth qualitative analysis based on Interpretative Phenomenological Analysis in line with Smith (1995).

RESULTS

Trainees mentioned the *social* benefits they feel can be gained from their participation in music making activities outside of school. More than half of the participants appreciated the development of social skills, the social interaction opportunities, the development of friendships while spending time with like-minded people, and the active social life that traveling to perform in various events often entails. On a social level, therefore, music making was perceived as an important social activity which helps build relationships with peers.

Benefits on a *personal* level expressed by participants included a sense of achievement and self-fulfillment, as well as feelings of being useful and musically satisfied. Music making was also perceived as an important means of self expression, as a relaxing and therapeutic activity which helps improve self-confidence, generates happy and positive feelings, is enjoyable but also helps participants enjoy and appreciate life more. On a purely personal level, therefore, some participants viewed their musical involvement as an enjoyable and "creative outlet," albeit a challenging one, which can provide release from pressures of work.

> I need it to feel happy and content.

Comments on personal development also included the musical benefits that most participants felt can be gained from such musical involvement. They thought that it can help them develop their own musicianship and interpretation of music, keeps their playing and technical standard high, helps them improve their knowledge of repertoire of different styles and genres, and therefore increases subject knowledge and keeps musical ideas fresh and up to date.

It is interesting to notice that most of these comments on musical benefits were often accompanied by their implications on classroom teaching. Therefore, in addition to having an effect on personal development, these musical gains were highly appreciated for their benefits on the actual teaching and learning environment. In other words, the skills developed can lead to more confidence in teaching by being able to incorporate more varied activities and skillfully demonstrate different techniques in class.

> Keeps playing/performing standard high, leading to more confidence at school.

On a *professional* level, respondents emphasized the positive effects of their active musical involvement outside of school on their ability to teach and their pupils' learning. By acquiring more relevant knowledge and experience through their own personal development, they felt able to address better pupils' diverse needs as they had the opportunity to share ideas and discuss resources with fellow musicians, further develop their communication skills, and draw links between classroom music with wider music making.

Interestingly, they felt that their musical experiences often enable them to act as role models for the students and develop higher expectations both from themselves and pupils' work. Even though they set higher standards in teaching and learning, some respondents felt that they can also adopt a more relaxing attitude toward class teaching. More general professional benefits were also expressed regarding, for instance, how these musical achievements can look good on a CV.

> Helps me relate music in the classroom to other aspects of music. Ideas used in other musical activities can be used in practical teaching.

Almost all participants in the study (32 of 34) felt that their active musical involvement outside school helps them become better teachers mainly because of their own confidence, enthusiasm, and musical experiences that can be passed on to pupils to inspire and motivate them.

> Yes, because I learn lots of skills which I can pass on to pupils. By talking about my achievements, it might inspire other pupils.

These trainees, therefore, felt that such musical activities increase their job satisfaction, make them happier, more energetic, and most importantly, help them focus on the personal significance of choosing music teaching as a career. All participants expressed the desire to be actively involved in music making outside of school as qualified music teachers.

> Helps me to focus on why I'm teaching music in the first place.

DISCUSSION

The study's findings interestingly draw a kind of ideal image of the classroom music teacher in secondary education. The variety of qualities and attributes mentioned depict a happy, enthusiastic, confident, and knowledgeable music teacher who can inspire, motivate, and help pupils achieve. These are highly accomplished musicians who recently graduated with their music degree and music making forms a significant part of their identity. They could be called "teacher-performers," following Mill's (2004) description of "performer-teachers." They are, in other words, teachers for whom performing is integral to their professional identity. They hope to continue making music as qualified music teachers as they feel that a variety of benefits can result from such involvement both for their own good and for the improvement of the teaching and learning environment.

The research findings indicate, therefore, that music teachers' musical involvement outside of school could possibly help address a number of problematic issues identified in the music education literature, such as avoiding burnout and having clear career goals (Hamann *et al.* 1987), maintaining musical enthusiasm (Drummond 2001), and allowing pupils to view their teachers as “real” professional musicians (Lamont *et al.* 2003). Finally, the lack of congruence between “school music” and “out of school music” (Hargreaves and Marshall 2003) or between the identities and attitudes of pupils and teachers (Hargreaves *et al.* 2003) could be reduced.

This research needs to be further explored and validated by future research that will shed light on the relevant attitudes of qualified and more experienced music teachers to find out whether a similar trend continues to exist.

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References

Bernard R. (2004). A dissonant duet: Discussions of music making and music teaching. *Music Education Research*, *6*, pp. 281-298.

Bransford J. D. and Brown A. L. (2000). *How People Learn: Brain, Mind, Experience and School*. Washington, DC: New Academic Press.

Drummond B. (2001). The classroom music teacher—Inspirations, aspirations and realities. The evidence from Northern Ireland. *British Journal of Music Education*, *18*, pp. 5-25.

Hamann D. L., Daugherty E., and Mills C. R. (1987). An investigation of burnout assessment and potential job related variables among public school music educators. *Psychology of Music, 15*, pp. 128-140.

Hargreaves D. J. and Marshall N. A. (2003). Developing identities in music education. *Music Education Research, 5*, pp. 263-274.

Hargreaves D. J., Welch G., Purves R., and Marshall N. (2003). The identities of music teachers. Paper presented at the *5th International ESCOM Conference*, Hanover University of Music and Drama, Hanover, Germany.

Lamont A., Hargreaves D. J., Marshall N. A., and Tarrant M. (2003). Young people’s music in and out of school. *British Journal of Music Education, 20*, pp. 229-241.

Mills J. (2004). Working in music: Becoming a performer-teacher. *Music Education Research, 6*, pp. 245-261.

National Center for Education Statistics (2002). *Arts Education in Public Elementary and Secondary Schools: 1999-2000*. Washington DC: US Department of Education.

Smith J. A. (1995). Semi-structured interviewing and qualitative analysis. In J. A. Smith, R. Harre, and L. Van Langenhove (eds.), *Rethinking Methods in Psychology* (pp. 9-26). London: Sage.

International Symposium on Performance Science
ISBN 978-90-9022484-8

A theoretical framework for examining foundational instructional materials supporting the acquisition of performance skills

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Conventional approaches to beginning instrumental performance instruction and the teaching materials supporting this process tend to stress technique acquisition and the ability to read written music. Available beginning level instructional materials tend to focus on skill development and note reading thereby doing little to facilitate the acquisition of functional aural skills, to create an awareness of tonality, or to help beginning students acquire the wide variety of conceptual understandings that might serve as a foundation to meaningful life-long engagement with music making. A framework mapping the multiple skills and concepts constituting musical knowledge and linking such maps to principles of instructional design might help music teachers construct more effective instructional materials. This paper uses concept mapping in developing such a theoretical framework.

Keywords: instructional design; music development; music learning; beginning instrument instruction; concept development

One of the paradoxes of music learning in the Western classical tradition is that the abilities required for performing and functioning in the aural art of music often rest on skills developed through decoding visual notation. Instrumental performance has a long history of instructing students through reading and practicing exercises in method books. The pedagogical materials in these books are sequentially and progressively arranged with the intention of helping the novice performer gradually acquire the motor skills necessary to play a wide range of repertoire. Performance skills are further refined as students are challenged by and progress through increasingly difficult pieces from the repertoire of the instrument which they are learning. If the instructional materials used with beginning students focus solely on acquiring the mechanical skills central to performing and do not support the development of aural, creative, and improvisational skills, students can easily develop the impression that music making is primarily a physical activity.

Meaningful performance, however, is the result of more than simply learning the mechanical actions necessary to play an instrument. Effective music making depends on conceptual understandings that direct the technical and expressive aspects of performing (Lehmann *et al.* 2007). These conceptual understandings are stored as mental representations that are refined and encoded in the cognitive system through interaction with and manipulation of a variety of musical materials. The acquisition of musical skills might be facilitated if instructional processes and teaching materials are designed to support the acquisition of mental representations central to musical understanding and performance. A major goal of this theoretical paper is to employ concept mapping to examine principles of instructional design and concepts from the emerging field of information architecture to develop a framework for analyzing the effectiveness of how pedagogical materials are presented, ordered, and sequenced in method books. Additionally, this exploration builds a visual map exploring the inter-relationships central to performance skills that the pedagogical literature suggests are central to music learning (e.g. aural skills, tonal awareness, rhythmic perception, stylistic awareness, practice skills, etc.).

MAIN CONTRIBUTION

As the order and organization of learning activities influences the processing and retention of information (Reigeluth 2007), the effective presentation of instructional materials is central to the overall objective of supporting internal learning processes. Therefore, instruction might be envisioned as a "deliberately arranged set of external events designed to support internal learning processes" (Gagné 1992). The information to be delivered through this process should be designed within an architecture and/or framework allowing both the explicit and implicit messages of instruction to become apparent (Gilchrist 2003). The effective presentation of instructional materials is central to the overall objective of supporting internal learning processes.

An examination of beginning instrumental method books used in American schools (Weber 1945, 1962; Ployhar 1977; O'Reilly and Williams 1997; Feldstein and Clark 2001) suggests that the primary focus of these

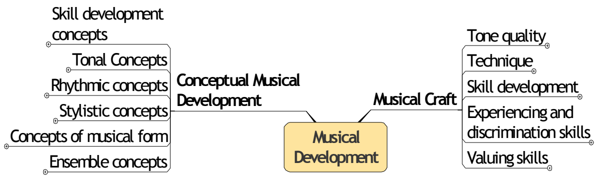

Figure 1. Musical development. The craft and conceptual aspects of musical development are interrelated and co-dependent. Improvements in conceptual understandings can result in improved music making skills. Informed and aware skill development will impact conceptual musical understanding.

instructional materials is the sequential development of technique and reading skills rather than of conceptual musical understanding. The pedagogical literature associated with beginning instrumental instruction (Ramsey 2001, Dvorak and Floyd 2000) suggests that musical understanding requires a wide variety of skills and concepts. Literature on musical development in beginning band instruction suggests developing and refining the craft of music making should accompany and support the acquisition of performance skills. The interrelationship between music craft and musical concept development are outlined in Figure 1.

Principles of Instructional Design

Attention to principles of instructional design has resulted in improvements to textbooks in mathematics and the physical sciences. These concepts offer principles for organizing and sequencing instructional materials as well as the principles involved in concept and skill acquisition. The principles suggest that instructional materials for music learning can be designed with an awareness of pre-attentive perceptual processing so that: (1) chunking of perceptual units is encouraged; (2) there is contiguity between the presentation of a concept and the information and exercises supporting that concept; (3) verbal coding of tonal and rhythmic concepts is emphasized; and (4) "emergent properties" of the music instruction process (i.e. warm-up and practice procedures) become apparent to the student.

General principles for evaluating instructional methods

The conceptual maps in this study provide a rich matrix of issues to consider when evaluating instructional materials. In general:

- Attention to pre-attentive perceptual processing is central to effective instructional design. The physical proximity of elements affects how detected information is structured and interpreted, determines how memory is organized, and facilitates the formation of chunks. Additionally, effective grouping allows *emergent properties* of the instructional message to become evident.
- Effective design facilitates acquisition of conceptual prototypes which should develop from interaction with attributes rather than by learning definitions or rules.
- Placing relevant terms in contiguity with an example of each attribute facilitates concept acquisition.
- Effective design develops, maintains, and enhances skills and concepts.
- Verbal coding and mental rehearsal enhance learning.
- Generative activities allow content processing and encoding.
- Tasks requiring mental effort enhance mental skill acquisition.
- Text, pictures, and color serve learning and concept acquisition.

Framework for evaluating method books

From the above principles, the following specific questions can help in the examination of beginning instructional materials:

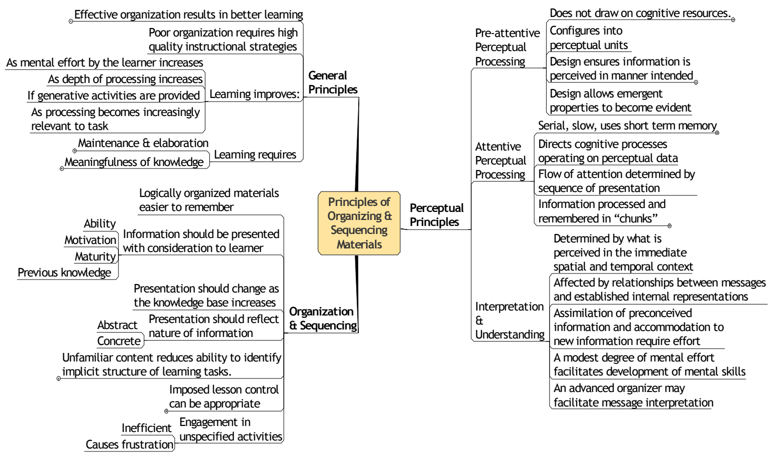

Figure 2. Principles of organizing and sequencing materials. Attention to perceptual principles and logical sequencing on materials influences the musical development of the student and can impact the pedagogical approach taken by the teacher.

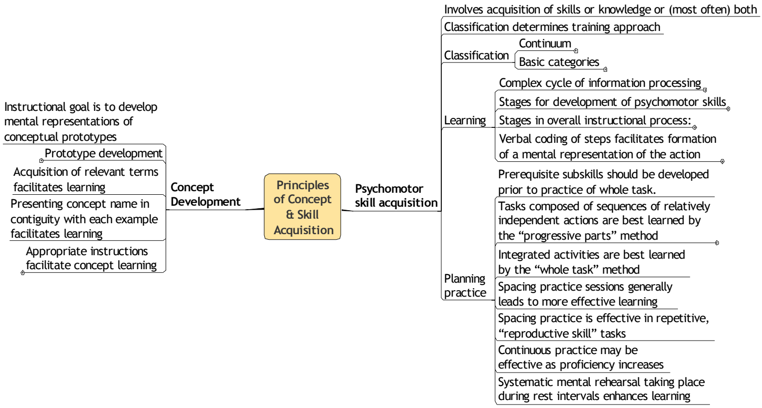

Figure 3. Principles of concept and skill acquisition. Information for these maps was drawn from the following: Fleming and Levie (1993), Gagné *et al.* (1992), Gilchrist and Mahon (2003), Jacbson (2000), Lachnit (2003), Schmidt (1991).

- How are tonal and rhythmic concepts presented and developed?
- Is verbal coding used to enhance these concepts?
- How are motor skills presented and developed?
- How does the method co-develop the mechanical (motor control) and conceptual (tonal/rhythmic) aspects of music?
- Are concepts labeled in contiguity with musical examples?
- Does the arrangement of the materials guide the student into establishing effective learning strategies and sequences?
- Do the tasks require mental effort that might enhance learning?

IMPLICATIONS

The task of creating instructional materials that might facilitate the acquisition of the multiple skills and concepts constituting musical knowledge presents numerous challenges. The conceptual maps and principles developed in this study offer a theoretical structure for examining the conceptual content of pedagogical materials and for analyzing how such materials might be designed to enhance and sustain the internal learning processes supporting musical performance.

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References

Douglas W. (1953). *The Belwin Band Builder: Part 1*. Miami, Florida, USA: Belwin-Mills Publishing.

Dvorak T. L. and Floyd R. L. (2000). *Best Music for Beginning Band*. Brooklyn, New York, USA: Manhattan Beach Music.

Feldstein S. and Clark L. (2001). *The Yamaha Advantage*. New York: Carl Fischer.

Fleming M. and Levie H. W. (1993) *Instructional Message Design*. Englewood Cliffs, California, USA: Educational Technology Publications.

Gagné R. M., Briggs L. J., and Wager W. W. (1992). *Principles of Instructional Design*. Forth Worth, Texas, USA: Harcourt Brace Jovanovich.

Gilchrist A. and Mahon B. (2003). *Information Architecture: Designing Information Environments for Purpose*. New York: Neal-Schuman Publishers.

Jacbson R. (2000). *Information Design*. Cambridge, Massachusetts, USA: MIT Press.

Lachnit H. (2003) The principle of contiguity. In R. H. Kluwe, G. Lüer, and F. Rösler (eds.), *Principles of Learning and Memory*. Basel, Switzerland: Birkhauser Verlag.

Lehmann A. C., Sloboda J. A., and Woody R. H. (2007). *Psychology for Musicians*. Oxford: Oxford University Press.

O'Reilly J. and Williams M. (1997). *Accent on Achievement: Book* 1. Van Nuys, California, USA: Alfred Publishing Company.

Reigeluth C. M. (2007). Order, first step to mastery: An introduction to sequencing in instructional design. In F. E. Ritter, J. Nerb, E. Lehtinen, and T. M. O'Shea (eds.), *In Order to Learn: How the Sequence of Topics Influences Learning* (pp. 19-40). Oxford: Oxford University Press.

Ramsey D. S. (2001) Beginning band—goals and objectives: Teaching music through performance in band—beginning band. In R. Miles and T. Dvorak (eds.). *Teaching Music Through Performance in Band*. Chicago: GIA Publications.

Schmidt R. A. (1991). *Motor Learning and Performance*. Champaign, Illinois, USA: Human Kinetics.

Weber F. (1945) *Belwin Elementary Band Method*. Miami, Florida, USA: Belwin-Mills Publishing.

International Symposium on Performance Science
ISBN 978-90-9022484-8

Youth and dance: Relation of university students with different types of dance

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In this paper, we present the results of a study examining the expectations of students beginning an undergraduate degree in dance and their relation to different types and activities in dance. In order to do this, we employed a specifically created questionnaire. We found that the dance students had already accumulated a significant amount of dance practice. Around half the group had practiced an average of seven years of ballet, while almost another half had practiced mainly street dances, though not for so many years. There are also other dance forms that had been practiced at some point by many of the subjects. Though they do not show much experience in other art forms, around one half had had some training in acting. More than a third of the group had worked as dancers, and a few as dance teachers. Expectations about the degree were mainly related to developing their performing qualities, showing little interest for the importance of theoretical studies. This is certainly related to the social lack of recognition of the necessity of higher education for teaching dance, since many teachers are previous dancers with little education in teaching.

Keywords: dance; types of dance; dance practice; dancer; dance teacher

When teaching in the area of performance, it is important to understand the student's motivations for the area (Buckroyd 1989, Stinson *et al.* 1990, Alter 1990, Macara 2003, 2006). With so many aesthetic currents (Agamben 1992), performing techniques, and teaching methods, it is fundamental for teachers to know how to adapt to the student's interests and how to approach each subject matter (Batalha 2004). In this paper, we present the results of a study examining the expectations of students beginning a university undergraduate degree in dance and their relation to different types of dance and a future as professionals

METHOD

Participants

For the purpose of the study we had one group of participants composed of students beginning the undergraduate degree in dance in the Faculty of Human Kinetics at the Technical University of Lisbon. We had a total of 14 students, representing almost 61% of the total number of students beginning the first year. Since we needed to administer the questionnaire on the first day of classes before the students had become acquainted with the school, we had to leave out many students who only entered the school later for administration reasons. The age average of the sample was 19.14 years. All participants were female.

Materials

For this investigation, we employed a specifically created questionnaire addressed to the respective group. This was complemented by individual interviews to help interpret the data.

To understand the situation of the students when entering the dance course, the specific questionnaire was created to address what types of dance they had practiced before, for how long, occupations related to dance and other arts, and expectations for the future.

The questions were closed or semi-closed, leaving space to add more responses than those requested in the questionnaire.

Procedure

The questionnaires were distributed to all students present during the first day of classes. They were self-completed, in a classroom, and the researcher was present in case there were any questions or queries. After collecting all the questionnaires, descriptive analysis was applied to the data, the results of which were compared with the interviews with the students.

RESULTS

After analyzing the answers to the questionnaire, we found out about the types of dance practiced by the subjects before entering the university. As can be seen in Table 1, ballet was the most frequently practiced dance form, followed by hip-hop and jazz dance. Though there are a variety of different dance forms practiced by some of the students, we can see that the group is

Table 1. Dance forms previously practiced and mean years of practice.

Type of dance	*Percentage of respondents involved*	*Years*
Ballet	57.1	7
Capoeira	7.1	4
Contemporary	21.4	4
Creative dance	7.1	1
Jazz dance	28.6	2
African dances	14.3	2
Brazilian dances	7.1	4
Latin dance	7.1	2
Rhythmic gymnastics	7.1	14
Hip hop	42.9	2
Ragga jam	7.1	2

Table 2. Experience in other art forms.

Art form	*Number of respondents (%)*
Circus arts	1 (7.1)
Dance in basic school	1 (7.1)
Dance group	1 (7.1)
Music/voice	1 (7.1)
Theatre	7 (50.0)

almost divided in two: one trained in ballet and the other based on street-dance.

Regarding years of practice, they seem quite significant. For ballet, the average years of practice is seven, for contemporary dance and *capoeira*, it comes down to four years, but for all other dance forms the number of years of practice is much lower, with the exception of one subject with 14 years of practice in gymnastics. This seems coherent, in the sense that it is relatively in accordance with the number of years necessary to be able to dance in each different dance form.

With regards to experience in other art forms, the most representative is theater, practiced at one time or another by half of the students (Table 2).

Several subjects had professional experiences in the area of dance. More specifically 35.7% worked as dancers, and 14.3% taught dance classes or participated in theater projects (Table 3).

Table 3. Work experiences related to dance.

Professional activity	*Percentage of respondents*
Dancer	35.7
Dance teaching	14.3
Theatre projects	14.3
Circus activities	7.1

Regarding their expectations in relation to the dance degree they were undertaking, the responses were varied (see Table 4). Most of them were expecting a good practical education, such as learning to dance, gaining a better knowledge about the body, getting acquainted with new dance forms, and learning techniques. Good theoretical education was mentioned much less, which may suggest that the students held low expectations concerning the theoretical demands of the degree. This may be related to the widely disseminated idea that one just needs to be a good dancer to become a good dance teacher. This is certainly related to the problem of lack of regulations for teaching dance in any context of Portuguese society. Even in the school system, the qualifications to teach dance are still not clear and do not demand a university degree.

DISCUSSION

In general we found that, though they were quite young, the dance students beginning the university degree had already accumulated quite a significant amount of dance training. Around half of the group had an average of seven years of ballet training, while almost another half had had training in mainly street dances, though not for so many years. There were also other dance forms that many of the subjects had been involved with at some point. Though they did not show much experience in other art forms, around one half had had some training in acting.

More than a third of the group had worked as dancers, and a few as dance teachers. This is only possible because in Portugal there are no regulations concerning teaching dance, so an academic degree is useful mainly for personal development. Maybe for this reason, expectations about the degree related mainly to the development of their performing qualities, while little interest for the importance of theoretical studies was expressed. This is certainly related to the lack of social recognition surrounding the necessity of higher education for teaching dance, since many teachers are previous dancers with little education in teaching. This is certainly a problem to be

Table 5. Expectations in relation to the dance degree.

Expectations	*Number of respondents*
Good practical education	5
Good theoretical education	3
Learn how to dance correctly	2
Learn to know the body	2
Become a teacher	2
Try new dance forms	2
Positive Expectations	2
Understand all the components of dance	1
Become a dancer	1
Learn new techniques	1
Gain knowledge to succeed in the performance world	1
Active, dynamic and creative practical classes	1
To contribute positively to the evolution of society	1

solved in this country, in order to develop the progress of this art form and its educational potential.

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References

Agamben G. (1992). Le geste et la Danse. *Reveu d'esthétique, 22*, pp. 9-12.

Alter J. B. (1990). Voices of dance students: 1953-1988. Paper presented at the *Annual Dance Education Forum,* UCLA, Los Angeles, California, USA.

Batalha A. P. (2004). *Metodologia do Ensino da Dança*. Lisbon: Faculty of Human Kinetics, Technical University of Lisbon.

Buckroyd J. (1989). The emotional needs of the young performer. Paper presented at the *9th International Conference of Dance and the Child International,* Roehampton Institute, London.

Macara A. (2003). Do you dance? A comparative study between physical education and dance students' interest in dance. Paper presented at the *AIESEP International Congress*, University of Madeira, Madeira, Portugal.

Macara A. (2006). Dance is a piece of my soul! Representations of dance among youngsters of African background! Paper presented at the *Congress on Research in Dance (CORD),* Tempe, Arizona, USA.

Stinson S. W., Blumenfield-Jones D. E, and Van Dyke J. (1990). Voices of young women dance students: An interpretive study of meaning in dance. *Dance Research Journal, 22*, pp. 13-22.

Author index

We wish to acknowledge the generous support
and assistance of the following organisations:

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