Viewpoint

Perception, Cognition, and Learning: Cognitive Research at the Music Academies in Denmark

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In recent years, the six Academies of music in Denmark have been subject to an increasing demand to do research. This is no easy task for institutions rooted in a practical approach to music with a long tradition of one-to-one teaching predominantly based on personal experience. At the Royal Academy of Music, Aarhus (RAMA) we are following a relatively ambitious research strategy based on an existing collaboration with the brain research centre, Center of Functionally Integrative Neuroscience (CFIN), at Aarhus University Hospital aiming at doing first-rate research at the international level presenting prospects of advancing the way in which we listen, play, and teach. In the following viewpoint I shall describe this collaboration, present some examples of the research that we are doing and discuss the possible implications of this research for the academies as well as for new music research.

Research strategies for the academies of music

The increasing demand for doing research at the academies of music, a trend that is also seen internationally, is apparent in the Education Executive Order for the academies in Denmark that now as something new includes research as a basis for the education. Moreover the research is subject to the standard research definition of the ministerial orders of the Ministry of Science, Technology, and Innovation implying increased demands for quality and rigour of the research.

This forces the academies to rethink the role played by research in the education as well as in the interface to the outside world. On one side, the music academies are synonymous with top level art and creative musical practice providing excellent conditions for research within the fields of musicology and music education. On the other side, due to the focus being on the creative artistic practice, the music academies lack general research competencies as well as the knowledge of scientific methods. Thus, strengthening research competence, enhancing the qualifications of the staff as well as having research in mind when hiring staff, must be top priorities for the academies in the years to come.

Owing to its practice-orientated rather than theoretical background, the academy is by default scientifically paradigm-neutral and can thus establish partnerships across academic boundaries, for example between the humanistic and scientific paradigms. For this reason, some of the most successful research projects taking place at the various academies in Denmark are multidisciplinary and multi-institutional co-operations using the resources and specialist knowledge of the local research environment, such as, for example, the collaboration between The Carl Nielsen Academy of Music in Odense and Department for Occupational Medicine at Odense University Hospital.

Gathering classical, rhythmic, and electronic music, the Royal Academy of Music, Aarhus, is probably the most versatile music academy in Denmark. This provides an essential background for doing research as it makes research projects across genres possible. At RAMA, we have been capable of establishing a firm collaboration with relevant faculties and departments at the University of Aarhus as well as at international research institutions resulting in seven joint Ph.D. scholarships, two of these successfully completed, in collaboration with CFIN, the Department of Computer Science, the Institute of Information and Media Studies, and the Department of Psychology, all at the University of Aarhus.

As we wish to bring the relationship between music and subject into our centre of attention, we have focused our research on the areas of musical perception, cognition and learning. The focus on these particular areas of research falls in line with the competencies of the academy as an artistic and educational institution, and provides a greater research potential in relation to the general activities of the academy.

Perception, cognition, and learning

Whereas the departments of music at the universities traditionally deal with music in a historical perspective, the music academies have a more natural predisposition towards practical and theoretical issues regarding the actual music making. Recently, some musicologists have advocated that studies of cognitive processes in relation to music in modern social and cultural life is a natural next step for music theory in general[1] as well as for the music academies in particular,[2] since traditional music theory only to a very small extent captures the phenomena characteristic of e.g. contemporary music for the concert hall, electronic music, and improvisational music such as jazz and rock.

Nowadays research in musical perception and cognition is a vastly growing field entailing a considerable proportion of publications, public awareness, and an increasing number of research communities and international conferences such as the International Conference on Music Perception and Cognition (ICMPC). This research covers a wide field. The research presented at the ICMPC conferences comprise studies of pianists' hand and finger movements, observational studies of rehearsal processes, studies on communication and music, signal processing, artificial

1 D. Huron, *Sweet Anticipation* (Cambridge, Mass.: The MIT Press, 2006), 374–75.
2 J. Brincker, 'Art, Research and Education at the Music Academies', paper given at the conference Research at the Academies of Music in Denmark, RAMA, 31 Oct. 2002.

intelligence, acoustics, behaviourism, and studies on how music affects the brain side by side with traditional musicology and ethnomusicology. A large proportion of this research is directed towards the educational practice.

Music in the brain

Recent years have seen a strong conceptual convergence in cognitive research on brain organization and the cognitive research mainly studying human competencies and the products of human activity. This convergence is exemplified in the collaboration on cognitive music research in the 'Music in the Brain' research group established between RAMA and CFIN. Our group aims to facilitate contacts between different scientific approaches to studying music and the brain, and to introduce this scientific field to a broader audience within the Danish music community. Through this collaboration, the academy has entered into a research environment offering connections to researchers and Ph.D. students from many different university departments, for example semiotics, anthropology, statistics, medicine, neurobiology, and psychology. The methodical and experimental aim of this research is to create an understanding of the way in which core human competencies such as music, communication, and language will affect the effective and functional connections of the brain and how factors such as competence, emotion, consciousness/awareness, and knowledge influence both actions and perception. This mainly involves experimental studies using brain scanning techniques and conceptual studies of cognitive semiotics, linguistics, psychology, and theoretical neurobiology.

Two important research questions

Contrary to music research, traditionally belonging to the field of humanities, brain research offers a novel scientific method of examining some of the basic questions concerning music. To students and teachers at the music academies two of the most interesting questions within this field are: How do we create emotions in listeners, and what influence does musical training have on our brains? In the following I shall try to give an overview of the current status of research that we and others perform into these two questions. First I intend to shed light on how emotions are transferred from music that we play to the brains of listeners propagating the viewpoint that anticipation is the key to understanding music and the effects of music on emotion. Second, I shall review some of the literature showing how musicians' brains change anatomically and functionally as a consequence of the intense training necessary for becoming an expert musician.

Music and emotion

Music is an integral part of life's highly pleasurable activities such as having good dinners, dancing, going to the movies, and hanging out with friends. Music can evoke a range of different emotions including everyday emotions such as happiness, sadness, surprise, and nostalgia, as well as emotions that are unique to music such as for instance the sensation of swing.

Recently, Juslin and Västfjäll have tried to establish a framework for understanding how music translates into human emotion.[3] Juslin and Västfjäll claim that the study of musical emotions has suffered from a neglect of the underlying psychological mechanisms evoking these emotions and propose that these mechanisms could be summarized as (a) Brain stem reflexes, (b) Evaluative conditioning, (c) Emotional contagion, (d) Visual imagery, (e) Episodic memory, and (f) Musical expectancy. A problem with these categories is that they are not ordered hierarchically, are not mutually exclusive and only category (f), musical expectancy, directly links musical and psychological mechanisms as such. This limits the scope of the proposed framework especially if its purpose is to act as a guideline for experiments trying to identify the brain systems involved in processing musical emotions. We believe that such a framework would be more useful if the mechanisms for evoking musical emotions were organized hierarchically, with musical expectancy as the most fundamental mechanism, as we have recently argued in a number of papers.[4]

It is hard to imagine that musical emotions are evoked without some sort of musical meaning assigned to what is heard, unless we think of emotions, such as fear, evoked by the mere occurrence of a loud sound. However, in this case it is questionable whether one would define this as music. Most music theoreticians consider musical anticipation as one of the principal means by which music conveys meaning and emotion. According to this point of view, understanding music is related to the anticipatory interplay between local auditory events and a deeper structural layer partly inherent in the music itself, and partly provided by mental structures in the listener induced by the music.[5] In short, the musical experience is dependent on the structures of the actual music as well as on the expectations of the interpreting brain. These expectations are dependent on long term learning of musical structures (culture dependent statistical learning), familiarity with a particular piece of music, short term memory for the immediate musical history while listening to a musical piece, as well as deliberate listening strategies.[6] Brain structures underlying musical expectation are thus shaped by culture as well as personal listening history and musical training.[7]

3 P.N. Juslin and D. Västfjäll, 'Emotional responses to music: the need to consider underlying mechanisms', *Behavioral and Brain Sciences*, 31 (2008), 559–75.

4 P. Vuust et al., 'Predictive coding of music – Brain responses to rhythmic incongruity', *Cortex*, 45/1 (2009), 80–92; P. Vuust et al., 'To musicians, the message is in the meter: pre-attentive neuronal responses to incongruent rhythm are left-lateralized in musicians', *Neuroimage*, 24 (2005), 560–64; P. Vuust and M.L. Kringelbach, 'The Pleasure of Music' in *The Pleasures of the Brain* (Oxford University Press, in press).

5 P. Vuust and A. Roepstorff, 'Listen up! Polyrhythms in brain and music', *Cognitive Semiotics*, 3 (Fall 2008), 131–59.

6 P. Vuust et al., 'It don't mean a thing … Keeping the rhythm during polyrhythmic tension activates language areas (BA47)', *Neuroimage*, 31 (2006), 832–41.

7 Vuust et al., 'To musicians'; P. Vuust, 'Den musikalske hjerne', *Kognition & Pædagogik*, 70 (2008), 58–69.

Moreover, as soon as one hears the first sound of a musical piece, structures enabling anticipation such as metre, tonality, and memory for particular musical pieces seem to be in place already and unavoidable. Thus, it is difficult to imagine any of the proposed mechanisms acting without the involvement of musical expectation.

Juslin and Västfjäll believe that musical expectation is something that develops slowly over time during listening experience and is not fully developed until the age of 5–11. This may well be correct if musical expectation is restricted to anticipation of complex musical structures such as the hierarchy of harmony dependent on long term learning.[8] However, expectation of the simple repetitive sound patterns, such as pitch deviants in successive pitch trains, has been detected even before birth, as indicated by the mismatch negativity (MMN, a brain wave indexing change in auditory patterns) measured by EEG/MEG (electroencephalography/magnetoencephalography). Moreover, in an elegant study, Winkler et al. showed that the auditory predictive model is updated for each new acoustic event in the sound environment, indicating that the anticipatory structures of music are in constant flux during the listening experience.[9] These results demonstrate that anticipation has a role at many levels in the hierarchy of musical structure.

Juslin and Västfjäll also claim that the degree of volitional influence on musical anticipation is low. However, we recently conducted a study in which musicians were asked to maintain either the main metre or a counter metre while listening to Stings 'The Lazarus Heart'.[10] In this experiment the subjects could volitionally impose two very different anticipatory frameworks onto the music. Deliberately listening to a melody from the perspective of two different tonalities would be another example of volitional control of the anticipatory framework.

The relationship between musical expectancy and emotion was originally explored by Leonard Meyer and has recently been elaborated by Huron in his book *Sweet anticipation*.[11] If we consider music expectation/anticipation as the fundamental mechanism for musical experience, then this maps nicely onto recent theories of how the brain works. Karl Friston has provided a promising model of brain function, in which predictive coding, as a central principle of brain function, provides an account of how the brain identifies and categorizes the causes of its sensory inputs. The model posits a hierarchical organization whereby lower level brain regions estimate predictions of their expected input based on contextual information through backwards connections from higher level regions. A comparison between prediction and actual input produces an error term that, if sufficiently large, will be fed back to call for an update of the model. This generates a recursive process, which aims at minimizing the difference between input and prediction. As the representational capacity of any neuronal assembly in this model is dynamic and context sensitive,

8 S. Leino et al., 'Representation of harmony rules in the human brain: further evidence from event-related potentials', *Brain Research*, 1142 (2007), 169–77.

9 I. Winkler, G. Karmos, and R. Naatanen, 'Adaptive modeling of the unattended acoustic environment reflected in the mismatch negativity event-related potential', *Brain Research*, 742 (1996), 239–52.

10 Vuust et al., 'It don't mean a thing'.

11 Huron, *Sweet Anticipation*.

this, among other issues, addresses the problem of top-down control. Lately, we have argued that processing violations of musical anticipation in different aspects of the music (e.g. rhythm/harmony) evokes different error messages (MMN/early anterior negativity (EAN)) and networks.[12] These effects are training dependent and can be explained by the predictive coding theory. Thus, in our opinion, musical expectation is a good candidate for the fundamental mechanism guiding the experience of musical meaning as well as emotion. Anticipation in itself may evoke a wealth of emotions such as awe, surprise, discomfort, the sensation of swing, etc. According to Huron this is due to a variety of different survival-related responses to anticipation in particular the 'prediction response' that rewards fulfilled expectations. However, anticipatory structures such as metre and tonality act indirectly on the other proposed mechanisms in that they form the basis for musical memory as well as for musical meaning.

If we consider the large amount of neuroscientific research on music that has been published in recent years, it is certainly true that studies of musical emotions seem to be pointing in different directions. Consider for instance the somewhat different activation patterns reported in studies in tow of our own studies of major and minor mode music supposedly evoking very simple emotions (happy/sad).[13] Even though these results may be due to many different factors contributing to the emotional state of the subjects under different experimental conditions, we agree with Justlin and Västfjäll that one of the reasons for these somewhat inconsistent results may be found in the lack of a theoretical framework. However, this framework needs to be organized hierarchically with music anticipation as the guiding mechanism.

Positioning music anticipation as the guiding mechanism for musical emotions may be a product of a musician's way of thinking, and it is certainly also useful to think of extra-musical mechanisms such as the ones described by Juslin and Västfjäll, in relation to composing or performing music. However, the predictive coding theory, that entails that learning is a way of enhancing the brain models for structure, an up-date of the brain's software so to speak, is a radical novel way of understanding learning and the influences of training on brain structure and function.

Learning music alters the brain anatomically and functionally

Thus, music perception and cognition is crucially dependent on the predictive model that meets the incoming acoustic signal and 'learning' is basically updating this brain model. To the music academies the most exciting aspect of neuroscience is

12 Vuust et al., 'Predictive coding of music'; P. Vuust and C. Frith, 'Anticipation is the key to understanding music and the effects of music on emotion', *Behavioral and Brain Sciences*, 31 (2008), 599–600.

13 K.J. Pallesen et al., 'Emotion processing of major, minor, and dissonant chords: a functional magnetic resonance imaging study', *Annals of the New York Academy of Sciences*, 1060 (2005), 450–53; A.C. Green et al., 'Music in minor activates limbic structures: a relationship with dissonance?', *Neuroreport*, 19 (2008), 711–15.

probably the scientific evidence from recent years regarding functional and anatomic differences especially in motor and auditory cortices between musicians and non-musicians. In the following I shall review some of the neuroscientific studies that we and others have performed investigating how learning music alters brain structure and predictive brain models in musicians.

Anatomy

There are various techniques with which researchers are able to measure the thickness of the human cortex. At Harvard Medical School in Boston a group of researchers lead by the German neurologist, Gotfried Schlaug have used the so-called voxelbased morphometry (VBM) with which it is possible to measure the amount of grey matter, containing the cell bodies of the neurons, in various areas of the brain. Gotfried Schlaug's group showed in 2001 that musicians possessing absolute pitch, the ability to name a pitch without the aid of reference pitches, were equipped with relatively more grey matter in the Planum Temporale, an auditory area on the dorsal temporal lobe of the left hemisphere, than musicians or non-musicians not possessing absolute pitch. By comparing the cortices of twenty professional musicians with the cortices of twenty amateur pianists' and forty non-musicians the same group also found enlargement of the cortex in pre-motor, motor- and sensori-motor cortices, areas likely related to coding from score to music, as well as enlargement in left inferior gyrus (Broca's area) an area considered as a language area by some researchers.[14]

Other studies have shown that string players' motor cortex have a larger representation of the left than he right hand, which is not surprising considering the specialized performance of string players' left hand, compared to the right. It is also known that the number of hours musicians practice per day correlates with the absolute and relative size of the cerebellum compared to the rest of the brain.[15] Corpus callosum, the main fiber connection between the two hemispheres is enlarged in musicians compared to non-musicians, indicating enhanced coordination between the two hemispheres.[16] From a musicians point of view Vanessa Sluming's study of musicians from Liverpool Symphony Orchestra showing that the volume of Broca's areas does not decrease with age for musicians compared to non-musicians, is reassuring evidence that music may have beneficial side-effects.[17] In other words, practising music preserves areas essential to music and language.

So even though the issue of how to interpret thickness of the cortex is currently under debate, it appears that daily music practising leads to structural changes in areas of the brain related to motor, auditory activity, and probably also certain areas essential to language. These studies mainly employ self reports in order to classify

14 C. Gaser and G. Schlaug, 'Gray matter differences between musicians and nonmusicians', *Annals of the New York Academy of Sciences*, 999 (2003), 514–17.

15 S. Hutchinson et al., 'Cerebellar volume of musicians', *Cerebral Cortex*, 13 (2003), 943–49.

16 G. Schlaug et al., 'Increased corpus callosum size in musicians', *Neuropsychologia*, 33 (1995), 1047–55.

17 V. Sluming et al., 'Voxel-based morphometry reveals increased gray matter density in Broca's area in male symphony orchestra musicians', *Neuroimage*, 17 (2002), 1613–22.

musicians and e.g. to calculate the number of hours of practice per day. There are however no studies investigating the direct correlation between musical abilities and thickness of the cortex.

In collaboration with the Canadian researcher, Mallar Chakravarty, I therefore scanned 17 jazz/rock musicians' brains using MRI (Magnetic Resonance Imaging) while testing their ear training abilities outside of the scanner.[18] The test we used was a modified version of the test used in entrance and final examinations at the Danish music academies known to provide a good indication of students' rhythmic abilities. It consists of 30 rhythmic $1\frac{1}{2}$ bar sequences that the student is asked to imitate. The average score for musicians was 14, within the range 7–19. We correlated this score with the thickness of the musicians' cortices using an advanced new method termed 'deformation-based morphometry'. We found significant local thickening of motor and auditory cortices according to increasing rhythmical competence. This corroborates and extends the results found in Schlaug et al.'s studies, but also indicates that their results probably have direct relation to participants' musical abilities, in this case their rhythmic abilities. A new finding was enlargements of the cortex in areas in the frontal lobe also known as BA 46 and BA 9, a part of the brain that is usually related to working memory. Six out of eight areas were localized in the left hemisphere, indicating that grey matter mainly in the left hemisphere enlarges while developing rhythmic competences. This left-lateralization corresponds well with results from our functional studies that similarly link rhythmic competence to activity in the left hemisphere.[19]

Functional brain scans using EEG and MEG

Brain scanning techniques are not limited to studying anatomy. When using MR (magnetic resonance) and PET (positron emission tomography) scanners it is actually possible to measure cerebral blood flow in various areas of the brain, providing information on which areas of the brain are active when subjects perform specific tasks. Electrical currents in the brain can be measured by EEG and MEG, completely silent techniques, making them preferred methods for studying brain processing of auditory stimuli such as language and music; even though the measured signals are more difficult to localize spatially.

A row of studies have shown functional differences between musicians and non-musicians and between people who play different instruments. Musicians are generally more sensitive to variations in intervals and musical contour. Musicians' brains respond faster to rhythmic and melodic incongruence, and musicians' brains react to rhythmic deviations of 20ms, as opposed to non-musicians who do not respond to such small deviations. Trumpet players and violinists are particularly sensitive to small variations in pitch.

18 M. Chakravarty and P. Vuust, 'Got Rhythm? Investigating the relationship between anatomy and rhythmic ability using Deformation Based Analysis', poster, Neuromusic III Conference, Montreal, 2008.

19 Vuust et al., 'To musicians'; Vuust et al., 'It don't mean a thing'.

Using MEG we measured brain responses to various disturbances of a rhythmic pattern in a group of nine jazz musicians, all students of The Sibelius Academy in Helsinki, and we compared this to a group of eight non-musicians.[20] Prior to the study all subjects were tested using the imitation test described above. Only musicians with a score of 16 or more and non-musicians with a score lower than 3 were allowed to take part in the study. Considering these rather strict inclusion criteria the musicians in this study were highly rhythmically competent whereas the non-musicians could be termed inept. In line with previous studies made by other researchers we found large and fast brain responses when the rhythmic pattern was broken. This activity was localized to the auditory cortex. The more interesting and rather surprising part of this study was the differences we found when comparing musicians to non-musicians. The amplitude of the response was generally much larger in the brains of jazz musicians than non-musicians, and whereas the jazz musicians' main brain responses were localized in the left hemisphere, the non-musicians responded with stronger activation in the right hemisphere. Furthermore, the activity in musicians' left hemisphere was much faster than the activity of non-musicians' left hemisphere, indicating a fundamentally different unconscious processing of salient musical events in skilled musicians.

Thus, one of the lessons that musicians can take from this research is that when discussing musical issues with non-musicians or musicians at a different level than themselves it is important to remember that the perception of music in these people may differ from their own on a very fundamental level.

Perspectives in a neuropsychological (biological) approach to music

So why is research in perception, cognition, and learning in general and neuroscientific music research in particular important to the academies of music and why should academies engage into a path seemingly difficult and cumbersome? I think that there are at least three good reasons for this.

First, I believe that music education will benefit greatly from cognitive research in music in the years to come, especially as methods such as brain scanning techniques become more trustworthy and available. This does not mean that musicians should expect tangible, practical advice that can be applied directly to musical learning and performance, nor that excellent instrumental teachers should give up their way of teaching shaped not only by a lifetime's experience but based on centuries of music teaching tradition. The neuroscientific research in music up till now has pre-dominantly provided valuable explanations of brain mechanisms underpinning musical abilities as well as general aspects of music cognition such as the above mentioned perception of musical emotions. However, over time, the insights gained from neuroscience may prove very useful not only as a way to informed hypotheses about the efficiency of specific musical training methods, but also neuroscientific methods may

20 Vuust et al., 'To musicians'.

be used to detect weaknesses and strengths in students' musical abilities. As an example of the latter I should mention our ongoing EEG-study in collaboration with CBRU (Cerebral Brain Research Unit, Helsinki) and the Sibelius Academy in Finland, in which we seek to find an objective method to determine musicians' abilities to discriminate deviants in basic aspects of music or sound such as pitch, rhythm, intensity, timbre, and location compared to a 'normal' population of musicians. Also, certain scientists propagate newly developed scientifically based strategies such as e.g. neurofeedback, which refers to the monitoring of one's own brain activity with a view to influencing it, as a way of optimizing concert performance.[21]

For practical advice on optimal training methods however, there is probably more to be gained through behavioral experiments. An example of this is the research performed by Hans-Christian Jabusch et al. who investigate the relationship between practice and pianists' performance.[22] One of their astonishing discoveries is that pianists at the age of 22–26 need more than 3 ¾ of an hour of daily practice in order to improve basic motor skills, a simple fact with obvious implications for students and teachers at the academies of music.

Second, anatomical and functional studies of the influence of music and musical expertise on the brain is an important way to learn more about the plastic potential of the brain, with implications for learning as well as rehabilitation. In studying musicians versus non-musicians scientists are offered a unique model to study brain plasticity in that musicians perform daily activities over a long stretch of years that enables them with amazing motor, auditory, coordination, and creative skills not only uniquely separating them from non-musicians but in many instances from musicians playing other instruments or styles of music. In recent years, many researchers within this field with a background in neuroscience have discovered that the only way to ask musically relevant questions is to collaborate with expert musicians, who have a profound knowledge of the inner workings of music. In this respect, teachers and students at the academies of music possess expertise that is not elsewhere available and only this kind of true interdisciplinarity can ensure research that is both rigorous and interesting at the same time.

Third, science in general presents a window between the music academies and the outside world, through which people can have a gaze at the hidden creative process of music that may appear mysterious to an outsider but to musicians is a natural part of their everyday life. Also, in doing research that is based on the daily experiences and challenges that expert musicians face may prove to be relevant not only for these musicians in particular, but have an impact that reaches beyond the music world. Studying the motor system in expert musicians, Eckart Altenmuller, who is both

21 T. Egner and J.H. Gruzelier, 'Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans', *Neuroreport*, 12 (2001), 4155–59; T. Egner and J.H. Gruzelier, 'EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials', *Clinical Neurophysiology*, 115 (2004), 131–39.

22 H.C. Jabusch et al., 'The influence of practice on the development of motor skills in pianists: A longitudinal study in a selected motor task', *Human movement science*, 28 (2009), 74–84.

neurologist, director of Institut für Musikmedizin in Hannover, and trained flutist, has found a way to help musicians suffering from the disabling condition known as focal dystonia or 'musicians cramp' by treating them with a combination of botox injections and muscle training. This illness is not restricted to musicians but may strike any professional that uses specialized fine-motor skills, such as e.g. typists or athletes. At RAMA we have several research projects with external implications. One of these is associate professor Bjørn Petersen's Ph.D. project. Petersen is investigating the possible beneficial effects of intensive music training of cochlear implantees trying to help them to a better speech perception as well as to be able to enjoy music and thereby to a substantially better quality of life. Following another line of research professor Wayne Siegel works with adaptive music: music that changes in interaction with the listener or with dancers' movements. This research may potentially be of great interest to computer game programmers who are interested in developing the auditory side of their products towards a more artistic and maybe more aesthetically interesting expression.

It is certainly not within the reach of all students and teachers at the academies of music to do research that meets academic gold standards and the academies of music must remember that many of their teachers and students are simply good at playing and teaching. However, though not all musicians find scientific endeavours worthwhile or within their reach, verbalizing about their art can create new audiences, and the up-grade of personal qualifications that doing research entails may open new career possibilities for teachers as well as for students. Research, however, should be seen as an opportunity for the academies of music, not as a frightening 'must'.