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Ken'ichi Miyazaki, Yuzuru Hiraga, Mayumi Adachi, Yoshitaka Nakajima, and Minoru Tsuzaki (Editors)

The ICMPC Series, and Some Current Research on Music Perception and Cognition

Diana Deutsch

Department of Psychology, University of California, San Diego, USA
ddeutsch@ucsd.edu

ABSTRACT

This paper is in three main parts. The first part describes the circumstances surrounding the founding of the ICMPC series in the late 1980s, and the first two ICMPC conferences, which were held in Kyoto and in Los Angeles. The second part describes some recent research by the author and collaborators. The first body of research concerns a new illusion, in which a spoken phrase is perceptually transformed to be heard as song, just through simple repetition. The second body of research concerns absolute pitch. It is argued, based both on published work and also a newly completed study, that exposure to tone language during the critical period for speech strongly influences the capacity to acquire absolute pitch for musical tones. The third body of research concerns a new illusion of pitch circularity, in which this is achieved with a bank of tones that each comprise a full harmonic series. This both extends the theoretical scope of pitch circularity and also has implications for the development of new music. Finally, developments in the field of music perception and cognition since the inception of the ICMPC series are considered.

I. THE ICMPC SERIES

It is an honor to be invited to write the Keynote Paper for the *10th International Conference on Music Perception and Cognition*, and to give a brief description of my ongoing research. This conference is of particular significance for me, as together with Kengo Ohgushi and Edward Carterette I co-founded the ICMPC conference series in the late 1980s. At that time, symposia and special sessions concerning music perception and cognition had been held at meetings of large societies such as the *Acoustical Society of America*, the *Audio Engineering Society*, and the *American Psychological Association*. In addition, small workshops had taken place in various countries; notably, an excellent and influential workshop series was held at Ossiach, Austria, organized by Juan Roederer. The Ossiach series involved a few invited researchers from several disciplines, including psychology, linguistics, neuroscience, computer science, music theory, and composition. It was at these workshops in particular that the need for a large international and interdisciplinary conference series on music perception and cognition became clearly manifest.

The idea of a conference series specifically entitled the *International Conference on Music Perception and Cognition (ICMPC)*, was born at a meeting of the *Audio Engineering Society* in Los Angeles in 1986. It was there that I had the pleasure of meeting Kengo Ohgushi, and he, Edward Carterette (then at UCLA) and I together discussed the possibility of such a conference series very seriously. We felt strongly that these conferences should be truly international in attendance and truly interdisciplinary in subject matter. Following this meeting, we rapidly decided that Japan would be an excellent place to hold the first of these conferences. The *Japanese Society for Music Perception and Cognition* was founded in 1988 so as to sponsor the first ICMPC in Kyoto. Takao Umemoto (whom I had met several times in La Jolla) was President of the first ICMPC, Edward Carterette was Co-President, Kengo Ohgushi was Chair of the Organizing Committee and I was Co-Chair of the Organizing Committee. Seeichiro Namba was Chair of the Program Committee and Sonoko Kuwano was Secretary (Figure 1).

The first ICMPC in Kyoto was a tremendous success. We were flooded with papers, and the conference was attended by distinguished researchers and scholars from all over the world. It had a strong interdisciplinary flavor, including sessions on memory, attention, performance, emotional response, rhythm and tempo, development of musical ability, music theory and musicology, computer simulation, perceptual effects of concert halls, music and brain function, among others. In the evenings we were regaled with remarkable performances of music and dance.

It was at the Kyoto conference that we decided to hold the 2nd ICMPC in Los Angeles. Following the Japanese model, I founded the (North American) *Society for Music Perception and Cognition* in 1990, and in 1992 the 2nd ICMPC was held in Los Angeles (I was President, Edward Carterette was Chair of the Organizing Committee, William Thomson was Chair of the Program Committee and Roger Kendall was Secretariat). The Los Angeles conference was also greeted with enormous enthusiasm, and was attended by an international group of distinguished scholars from different disciplines.

Following this, other such societies were founded, including the *European Society for the Cognitive Sciences of Music*, and the *Asia-Pacific Society for the Cognitive Sciences of Music*, and sponsored by such societies ICMPC conferences were held at two-year intervals in Belgium, Canada, Korea, England, Australia, and the United States.

From the papers presented at the 10th ICMPC, it is clear that the vision of an international conference series that would successfully foster interdisciplinary collaboration in the study of music perception and cognition has been realized. This conference again has a strong international flavor, with 400 accepted papers from Asia (including Japan, Korea, China, Taiwan, Israel, Turkey, and India), Africa, Australia, the United Kingdom (England and Scotland), the European continent (The Netherlands, France, Belgium, Germany, Austria, Sweden, Denmark, Norway, Finland, Poland, Spain, and Switzerland), and the Americas (the United States, Canada, and South America). A very broad range of topics is here covered, including music and brain function, cognition of musical structure, perception of musical patterns, music and language, emotional and aesthetic response, development of musical competence, expressive performance, timing issues,

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Figure 1. Organizers of the first ICMPC in Kyoto, October 19, 1989

computational modeling, multimedia, cross-cultural issues, social issues, perception of musical instrument sounds, effects of music on health, and unusual musical abilities and disabilities. Particularly noteworthy are the many papers that report findings stemming from collaborations that are both interdisciplinary in scope and international in authorship.

It is interesting that the scientific study of music has taken so long to come into its own. Much music theory is still rationalistic in nature, and many music theorists still believe that provided the musical structure of a piece is logically coherent, the listener should, in principle, be able to apprehend it. This belief, as we have now demonstrated in many ways, is simply incorrect: Music as perceived cannot be assumed to be the same as that in a written score, or as might be imagined from reading a score. Furthermore, there are substantial differences between listeners in how even simple musical passages may be perceived. Some of these differences are based on hardwired factors, and some are due to exposure to other sounds – both musical and extramusical, in the latter case particularly the sounds of speech. Relationships between music and speech form a large part of ongoing research in my laboratory, and it is to this aspect that I now turn.

II. SOME ONGOING RESEARCH

A. A Conundrum Involving the Relationship Between Music and Speech

One theme that is strongly represented at this conference involves modularity of processing. In particular, a number of papers address the issue of whether speech and music are subserved by different and specialized neural circuitries, or whether they are the function of common neural circuitry. In this context, we are investigating a strange conundrum involving the relationship between speech and music.

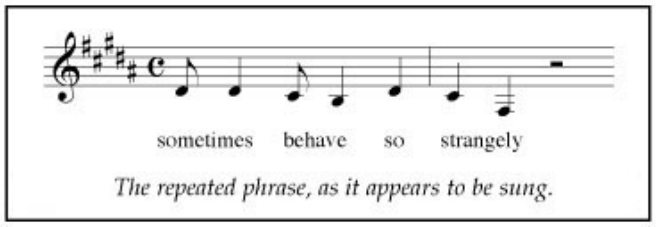
It is generally assumed – and this assumption is eminently reasonable - that whether one perceives a phrase as spoken or as sung depends on the features of the presented signal. For example, sung words tend to be comprised of syllables that have longer durations and flatter pitch contours than those of speech. So we might assume that at some stage in the auditory system, the signal is evaluated for certain critical features, and based on this evaluation, it is then routed to neural circuitry that processes the information in such a way as to signal either 'speech', or 'song'. However, I recently discovered a surprising phenomenon which demonstrates that the matter is

more complicated: A particular spoken phrase can be made to be heard convincingly as sung rather than spoken, and this perceptual transformation occurs without altering the signal in any way, but simply by repeating the phrase several times over.

The spoken phrase occurs in a sentence in the opening commentary of my compact disc '*Musical illusions and paradoxes*' (1995). The full sentence is:

'The sounds as they appear to you are not only different from those that are really present, but they sometimes behave so strangely as to appear quite impossible.'

When you listen to this sentence in its entirety, it clearly appears as spoken – as indeed it is. Yet when you play the phrase that is embedded in it '*sometimes behave so strangely*' several times over, a strange phenomenon emerges: At some point, instead of appearing to be spoken, the phrase appears to be sung, as in the Figure below.



The repeated phrase, as it appears to be sung.

The repeated phrase is presented as a sound demonstration on my compact disc '*Phantom words, and other curiosities'* (2003).

As a further point, when, having heard this phrase repeated and so perceptually transformed into song, you then listen to the entire sentence again, it begins by sounding as speech – just as before. However, when you arrive at the phrase '*sometimes behave so strangely'*, my voice appears suddenly to burst into song. Furthermore, once this phrase has been heard as sung, it continues to be heard as sung even when it is presented again just once after several weeks have elapsed. This presents a striking example of rapid, highly specific, and long-lasting perceptual 'learning', and shows that the circuitries underlying perceived speech and song can accept the same input, but they process the information in distinct ways so as to produce different outputs.

Together with Rachael Degenshein and Trevor Henthorn, I have investigated the conditions under which this repetition effect occurs, and we have found that changing the pattern slightly on each repetition – for example, transposing it slightly – can reduce or abolish the perceptual transformation effect. It appears, therefore, that exact repetition of the phrase is necessary for this curious perceptual change to occur. In addition, Marty Sereno, Adam Tierney and I are investigating the changes in patterns of brain activation that occur concomitantly with the perceptual transformation of a spoken phrase into song. Since the identical signal is responsible for both types of percept, the uncovering of such changes at the neural level should help to pinpoint the brain areas involved in perception of melodic patterns rather than speech intonation contours.

B. Absolute Pitch — A Connection Between Speech and Music

Another theme that occurs in several papers presented at this conference involves absolute pitch. Considered simply in terms of musical notes, absolute pitch poses an enigma. What would be the adaptive significance of a musical capacity that is subject to a critical period with the same time course as that of speech, and that is also very rare? As a further puzzle, why should most people possess an implicit form of absolute pitch (as evidenced, for example, in listening to the tritone paradox (Deutsch, 1992) and yet be unable to perform the simple task of naming notes that are presented in isolation?

The impetus for my research program on absolute pitch came from a discovery I made in conversing with speakers of tone language – in this case, Vietnamese. When I attempted to repeat Vietnamese words back to these speakers, they insisted that, in order for a word to have meaning – or at least the correct meaning - I needed to repeat it back within the same narrow pitch range. (I should mention that these were monolingual speakers of Vietnamese – bilingual speakers who have been in the U.S. for a while have learned to transpose verbal materials, so are more forgiving of pitch differences.)

In our first study we demonstrated that speakers of Vietnamese and Mandarin showed a remarkably precise and stable form of absolute pitch in enunciating the same list of words on different days (Deutsch, Henthorn, and Dolson, 2004). Based on these findings I hypothesized that absolute pitch may have originally evolved to subserve speech, along with other features such as vowel quality. I further hypothesized that absolute pitch for tones would be acquired during the first year of life, during the critical period in which infants acquire other features of their native language. When these children reach the age at which they can begin to take music lessons, they should then be able to acquire the pitches of musical tones in the same way as they would acquire the tones of a second tone language. Children who have instead acquired an intonation language would not have this initial advantage, and so would need to acquire absolute pitch for musical tones as though they were attempting to acquire a first language later than would be normal.

This hypothesis led to another study, in which we examined the prevalence of absolute pitch among music students in two different music conservatories: We compared students at the Central Conservatory of Music in Beijing, who were speakers of the tone language Mandarin, with those at Eastman School of Music in the U.S., who were speakers of intonation language. The tone language speakers far outperformed the intonation language speakers on our test for absolute pitch (Deutsch, Henthorn, Marvin, and Xu, 2006).

Now one might argue that the explanation for this difference between the two groups of subjects lies not in language but rather in ethnicity. However, together with Kevin Dooley, Trevor Henthorn, and Brian Head, I just completed a direct-test study on students at the Thornton School of Music at the University of Southern California, in which we controlled for ethnicity. We found that the prevalence of absolute pitch was significantly and substantially higher among those students who stated that they spoke a tone language fluently than among those of the same ethnicity who stated that they spoke a tone language poorly or not at all. This new study points strongly to

language as the determining factor responsible for the enormous difference in prevalence of absolute pitch among speakers of tone language and intonation language. More generally, it appears that absolute pitch for music provides an example of a capacity that involves brain structures that also subserve speech.

C. A New Pitch Circularity Illusion

A third area of research that is the subject of intensive investigation in our laboratory concerns the circular component of pitch. Roger Shepard and Jean-Claude Risset had earlier produced remarkable pitch circularities with the use of tones consisting of components that were related by octaves. Such tones are heard as clearly defined in terms of pitch class but ambiguously in terms of height. It seemed to me that it would be useful to extend the scope of pitch circularity by creating tones that were ambiguous with respect to height but nevertheless comprised full harmonic series. If banks of such circular tones could be created, the theoretical scope of pitch circularity would be extended. In addition, the algorithm for creating such tones could then be used as the basis for creating tones that sounded like those of natural instruments (piano, violin, voice, and so on) but that also exhibited pitch circularity.

The algorithm that I came up with was based on the fact that when you gradually remove the odd-numbered components of a harmonic series, leaving only the even-numbered components, the tone appears to glide up an octave while remaining consistently in the same pitch class. So one begins with a bank of twelve tones, each of which consists of the first six harmonics at equal amplitude, and with f0 varying in semitone steps. Then as f0 descends, the amplitudes of the odd-numbered harmonics are reduced relative to the even-numbered ones by 3.5 dB for each semitone step. Each reduction in amplitude of the odd-numbered harmonics raises the pitch height of the tone by a small amount. In consequence, at the lowest f0 the odd-numbered harmonics no longer contribute to perceived pitch, so that the tone is heard as displaced up an octave, and in this way pitch circularity is produced. In an experiment involving two such scales, highly significant circularities were demonstrated (Deutsch, Dooley, and Henthorn, in press). At present, together with signal-processing colleagues, we are creating variants of these tones so that they sound like those of natural instruments; this could prove useful in the development of algorithms for new music.

III. CONCLUSION

With the enormous advances in computer technology that have occurred over the last 20 years, we can now generate, transform, and analyze sound patterns in ways that were unknown at the time the ICMPC series started. This has hugely expanded the scope of research on music perception, cognition, and performance. Another important technological development that occurred during this time period involved brain scanning: We now have at our disposal several different means of evaluating the changes in patterns of brain activation that occur in listening to, imagining, and performing music. This should greatly facilitate research on issues concerning modularity of musical processing, relationships between music and language, the neurological bases of emotional and aesthetic response to music, and so on. Furthermore, internet surveys (unknown at the time of the first ICMPC) have proved very useful for addressing certain issues concerning music, and for the recruitment of subjects with unusual abilities and disabilities. With these new developments, our field is poised to make considerable further strides.

Also during this time period, there has been a growing awareness in the scientific community of the importance of research on music for addressing longstanding issues in established fields (for example in psychology, issues concerning perception, attention, memory, and abstract cognitive representation). In consequence, much work on music is now accepted in mainstream journals, even if such papers contain ideas and terms with which many of the readers would be unfamiliar. This is a very welcome development. However, I believe that it is important that our interdisciplinary field should remain cohesive, as it is today, and that it not be fragmented into different subareas. Interactions such as take place at the ICMPC series are as important as ever for our growing field to remain strong and flourish.

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