Prof. Dr. Stefan Koelsch

**Professor for Biological Psychology and Music Psychology,
Freie Universität Berlin**

Why do you consider music psychology an ideal tool for analyzing the brain?

Listening to music and making music engage a large array of psychological processes, including perception and multimodal integration, attention, learning and memory, syntactic processing and processing of meaning, information, action, emotion, and social cognition. This richness makes music an ideal tool to investigate human psychology and the workings of the human brain: Music psychology inherently covers and connects the different disciplines of psychology, such as perception, attention, memory, language, action, and emotion. Music psychology is particularly valuable because it can combine these different disciplines in coherent, integrative frameworks of both theory and research.

Traditionally, psychologists and neuroscientists work on small "islands" on which they investigate one of these psychological disciplines without thinking much about other disciplines. For example, psycholinguists usually use syntactically incorrect sentences to investigate syntax processing, such as "the girl plays a violins." In music psychology, we can also investigate music-syntactic processing with a "wrong" harmony. But a music psychologist will naturally also ask questions, such as "Which emotional effects does this event have for the listener? Which meaning emerges from such an event? How do listeners try to understand the intentions of the composer when composing such a chord? Are the pre-motor hand representations of a musician activated when hearing such a chord in order to correct it?" Such thinking is a major advance in psychology and in neuroscience, because scientists are now beginning to connect the different "islands" by using music as a medium. Other than classically viewed, this makes music psychology the fundamental discipline of psychology.

Why do people have different reactions to the same piece of music?

First, we have to clarify what "reactions" are. These can be perceptual reactions, cognitive reactions, motor reactions, or emotional reactions. Let us start with cognitive reactions. Similar to language, we will react differently to certain grammatical and meaningful musical events if we know, e.g. the musical grammar. Someone who has never heard Western music will not recognize an irregular chord function, similar to someone who does not speak English, and will thus not recognize that the sentence "the girl plays the violins" is syntactically incorrect. Similarly, someone who does not know, e.g. the song "Happy Birthday To You," will not understand what the melody means. On the other hand, if a

musical piece sounds "happy" or "sad" due to a similarity to a "happy" or a "sad" voice, everyone will recognize such an emotional expression, regardless of whether he or she has ever heard Western music before.

With regard to motor reactions, we know that musicians react with pre-motor activations when they are presented with music played on their instrument, even if they do not actually move. Likewise, many musicians perceive more details of acoustic information due to their extensive training. Thus, their perceptual reactions to music are different from those of non-musicians.

With regard to emotional reactions, several different factors come into play. For example: listening habits lead some to like dissonant music whereas others cannot stand it. Some people have personal memories associated with a particular piece or song, and, therefore, like it particularly well. Others have a personal connection to emotions expressed by the music that others do not have. Some have a different understanding of a piece of music that others do not have. All these factors contribute to different emotional reactions to music.

Could you tell us about the underlying mechanisms of emotional responses to music?

As already mentioned, there are several principles that contribute to the phenomenon of music-evoked emotion. I have already addressed some of these principles. Evaluation is one of them: Some like more dissonant music whereas others do not. A musical performance might be so good that even though I do not like the piece particularly well I still react very positively to the music. I have also already talked about the phenomenon that music can bring back certain memories associated with the music. I have also talked about the phenomenon that an unexpected musical event can evoke an emotion, such as surprise. Another principle is "emotional contagion," where happy music can make us smile, which then actually makes us happier. Moreover, inventing music during composition, improvisation, or even when whistling along with a song, can be fun, as well as understanding music produced by other individuals. Finally, humans engage in social functions when listening to music, such as communication, coordination of movements, and cooperation. These social functions lead to increased social cohesion, which can evoke feelings of joy and happiness.

Do adults and children perceive and process music differently? If so, how?

I have already mentioned several factors that contribute to the phenomenon that people have different reactions to the same piece of music. These factors also apply to differences between adults and children. However, I should also add that the musicality of children, and the implicit knowledge that children have about music has long been severely underestimated. We now know that already 30-month-old children have a surprisingly sophisticated implicit knowledge about musical regularities. That is, their brains show reactions to music-syntactically incorrect sequences, some of which are even difficult to detect by their parents. We also know that children express an enormous interest in music.

The tremendous musicality and the huge interest in music of the child's brain is important, because this also helps the child to learn language. Children learn languages due to the "musical" features of spoken language (speech melody, speech rhythm, pauses between words, the timbre of speech, etc.), and, therefore, their musicality helps them to acquire a language. It is also worth noting that in children who do not communicate with language, such as those who suffer from autism, communication is usually well possible with music. Functional neuroimaging experiments have revealed that the brains of children with autism do not show activation of language areas in response to language, but in response to music! Other studies have shown that certain aspects of language perception are developed earlier, and more strongly in children with musical training. Therefore, all children should be encouraged to make music, and they should be given the opportunity to do so.

How does music affect learning and memory?

Interestingly, recent studies have revealed that the brain hosts a special memory for music. This was shown in a professional cellist who, due to a brain illness, had lost much of his memory about factual knowledge and the memory about episodes in his life. Although from Germany, he could not remember the name of any German river or chancellor, and he was neither able to report biographical details from childhood, youth or adulthood. However, he could remember musical pieces exceptionally well, and he could also still play the cello. Moreover, although he could not learn new information, such as faces or objects, he could learn and memorize new musical pieces. Findings such as these open intriguing new perspectives for therapeutic interventions and new methods to help individuals with memory problems, including neurodegenerative diseases such as Alzheimer's disease.