NeuroCampus – Inside Out:

Peter Keller

Group Leader at Center for Music in the Brain, Department of Clinical Medicine

Keller's group studies the underlying mechanisms of coordination in group music making using various methods from motion-tracking and computational modelling to neuroimaging and brain stimulation. A main focus is placed on how people achieve precise yet flexible interpersonal synchrony, and why their ability to do so differs.

Peter Keller. Photo: Karoline Klitgaard

Can you describe your research in a nutshell?

In my group, we investigate how people interact through music. We study the communicative function of group music making and examine the underlying psychological processes and neural mechanisms.

We work with a 'telescopic strategy' where we examine interpersonal coordination using a range of different approaches.
One approach involves going to the concert hall or music studio and collecting audio and video recording of musicians doing what they do naturally. Here we have found it useful to study body movements that can be used for conveying meaning in a performance as well as for providing cues that help to coordinate with other performers. We also study musicians under more tightly controlled conditions in the lab, where we can attach, 'markers' to their bodies and use motion-tracking techniques to, analyze their movements in three-dimensional space with much finer detail than from videos in real life scenarios.
In the lab, we also study the produced sounds using electronic instruments, e.g. digital pianos, where we can get high-resolution information about the timing and force of each key press. These lab studies provide a window into the psychological processes underpinning musical coordination. For instance, we can study the role of knowledge in predicting co-performers' actions by letting people know what their partner is going to play for some pieces, but not for others, and then examine the impact that this has on their joint performance.
Additionally, we apply a computational model to data collected in these sorts of scenarios. The model consists of three modules: One module describes how people react to errors by altering their own timing, a second focuses on how people predict other person's timing, while the third brings these together, dealing with dividing attention between self and others, in. The model allows us to use a mathematical procedure to estimate parameter values for each module for each individual, reflecting their idiosyncratic capacities for the various underling processes.
Lastly, we study how these processes work together in the brain using fMRI, EEG and stimulation techniques. We have for instance found that electrical current applied to a particular pathway at a specific frequency can boost interpersonal synchrony.

How did you end up where you are today?

Originally, I enrolled in a music performance degree in Australia, where I encountered a teacher who emphasized the importance of developing skills as an ensemble performer in addition to those required as a soloist. After switching to music theory and composition, while studying psychology on the side, I realised that these different disciplines could be combined. This led me to do a PhD in the attentional processes related to how one divides attention between self and others in group music making. Following that, I entered the world of neuroscience while working at research institutes in Germany and Australia. This multi-disciplinarity paved the way for my 'telescopic' approach, which is also compatible with work at the Center for Music in Brain, where I started last year.

What is the potential implications of your research?

The potential implications of our research extend in several different directions. Firstly, the methods and various tests that we developed can be used clinically for the assessment and treatment of conditions characterized by motor symptoms such as stroke or Parkinson's disease. Specific reactive and predictive error behavior has e.g. been associated with focal lesions in different brain regions, incl. the cerebellum and basal ganglia.
On the technological front, our computational model has been used in human-machine interaction, specifically in the optimization of human-robot teaming.
Studying group music making has even clearer implications for music education. Our approach allows us to examine individual differences in musicians' ensemble skills, which can then inform targeted practice depending on roles in a group and their current capacities.

What does a (local) strong neuroscience research network mean for you and your research?

One of the first things that struck me when moving to Aarhus was that we have so many experts in various areas relevant to my research field, e.g. MRI-methodology, connectivity analysis, and whole-brain dynamics, all located here at the same place. This makes it easy to meet and interact and create new ideas.

If you had unlimited resources to conduct a big, multidisciplinary neuroscience project, what would you like to do?

I would like to establish an international chamber music competition for upcoming artists, where participants are recorded and studied both before and during the competition using video analysis, questionnaires etc. This would present an extraordinary opportunity to study group music making in real life. In addition, I think it is important to bring science and the outside world closer together and this competition would be a perfect opportunity for sharing current knowledge from the science of music with both the competitors as well as the public.

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