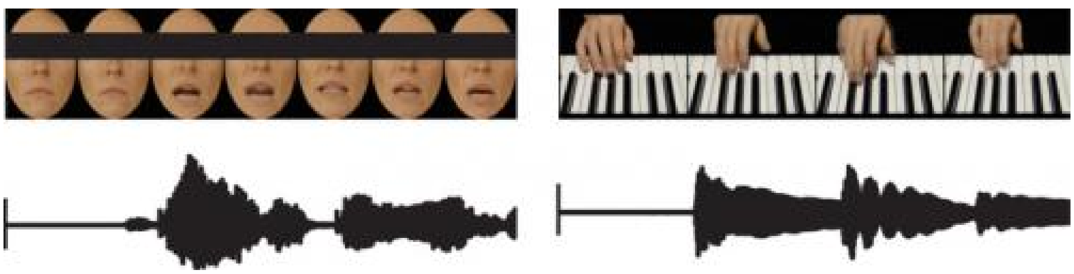
Medical Xpress

Playing music alters the processing of multiple sensory stimuli in the brain

November 24 2011



A segment of the audiovisual speech (left) and music (right) stimulus. © HweeLing Lee/MPI for Biological Cybernetics

(Medical Xpress) -- Over the years pianists develop a particularly acute sense of the temporal correlation between the movements of the piano keys and the sound of the notes played. However, they are no better than non-musicians at assessing the synchronicity of lip movements and speech.

This was discovered by researchers from the Max Planck Institute for Biological Cybernetics in a comparative study on the simultaneous brain processing of stimuli from different senses by musicians and non-musicians. The researchers also used functional magnetic resonance imaging in their study to map the areas of the brain active during this process. According to their findings, in pianists, the perception of asynchronous music and hand movements triggers increased error signals in a circuit involving the cerebellum, premotor and associative areas of the brain, which is refined by piano practicing. The study shows that our sensorimotor experience influences the way in which the brain temporally links signals from different senses during perception.

In a world full of stimuli which affect all senses, the human brain constantly has to link the impressions we perceive in a way that makes sense. We learn through experience, for example, that the synchronous events that arise in a busy bar setting, such as the lip movements of a particular person and the sound of a certain voice, belong together. HweeLing Lee and research group leader Uta Noppeney from the Max Planck Institute for Biological Cybernetics in Tübingen study how the brain integrates stimuli from several senses and how the circuits in the brain change as a result of learning. In their latest study, they examined how well 18 amateur pianists were able to perceive the temporal coincidence between finger movements on the piano keys and a piece of piano music and between lip movements and spoken sentences as compared with 19 non-musicians. “For this study, we availed of the fact that the pianists specifically train in an activity, in which several sensory stimuli, that is visual and auditory information, movement and the striking of the piano keys, have to be connected,” explains Uta Noppeney.

During the experiment, the finger or mouth movements were advanced or delayed in relation to the sounds heard at intervals of up to 360 milliseconds. The study participants were requested to specify when asked whether the events were synchronous or asynchronous. Using the same film and sound material and the same participants, the experiments were then repeated using functional magnetic resonance imaging (fMRI). In this case, the subjects remained passive and the machine recorded the areas of the brain that became active during the automatic perception of the synchronous and asynchronous signals.

The experiments revealed that the pianists were significantly more accurate than the non-musicians in assessing whether the finger movements on the piano and the sounds heard coincided temporally or not. “The window for the temporal integration of the stimuli in the pianists is clearly narrower than in non-musicians,” says HweeLing Lee. However, the same differences were not observed in the experiments involving spoken sentences and lip movements – both groups recorded similar performances here. In principle, asynchronicity in language and music activates the same areas in the brain. However, the fMRI scans showed that, in the experiment with the pianists, asynchronous music triggered a stronger signal in a circuit involving the left cerebellum, a premotor and associative region in the cerebral cortex than in the non-musicians.

“The processing of stimuli in the brains of the pianists points to a context-specific mechanism: as a result of their piano practice, a forward model involving the cerebellum and premotor cerebral cortex is programmed in the circuit which enables the individual to make far more precise predictions about the correct temporal sequence of the visual and auditory signals,” explains Uta Noppeney. “An asynchronous stimulus triggers prediction error signal.” The researchers see this as an important indication of how the brain can generally react in a flexible way to sensorimotor experience. Whether pianists would perform equally well in the assessment of violin music and whether more intensive music playing would influence language processing in the brain remain open questions. “For the next stage in the study of the processing of multiple sensory stimuli in the brain, we will have to train the participants in a specific way so that we can investigate the effects in greater detail,” says Uta Noppeney.

More information: HweeLing Lee, Uta Noppeney, Long-term music training tunes how the brain temporally binds signals from multiple senses, *PNAS*, doi: 10.1073/pnas.1115267108

Provided by Max-Planck-Gesellschaft