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Activity of the mirror neuron system to action-related sounds in a three-dimensional sound reproduction system.

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Abstract:
The mirror neuron system is the brain region that is activated when seeing the sight of, or hearing the sound of other's action. We investigated whether the mirror neuron system shows differential activation for action-related and non-action-related sounds and whether it is susceptible to the quality of the sounds. BoSC system (Boundary Surface Control system) is a three dimensional sound field reproduction system based on the boundary surface control principle. The sound used in this experiment was recorded by a 80-ch microphone array and was reproduced through a 62-ch speaker array in a dome structure. Sixteen young adult subjects (14 male, 2 female, aged 22.1±0.68, mean±SD) participated in the experiment by obtaining the written informed consent. The sounds of handclapping, tearing up a sheet of paper, and balling up a sheet of paper were prepared as action-related sounds for this study, as well as the sounds of metronome, shredding a sheet of paper, and flushing the toilet, as non-action-related sounds. These sounds lasted for 4s. Each sound was presented for 20 times with a pseudo-randomized order. Inter-stimulus interval was set at 4s. The sound was presented either through 1-ch or 62-ch of the BoSC speaker system. Electroencephalogram (EEG) signals were recorded continuously by 4 pin-type active electrodes (C3, C4, Cz and Fz). Bipolar electrooculography (EOG) were also measured. EOG artifacts were removed from the recorded data by using the independent component analysis (ICA). The resulting data were transformed by a continuous Morlet wavelet transform. Attenuation of EEG power in the mu frequency range (8-12Hz) over the motor area reflects the activity in the motor area and regarded as mirror neuron system activation during hearing sounds in this study. The result showed that CZ and C4 were significantly activated to action-related sounds through a 1-ch speakers (CZ: t=2.36, C4: t=1.76, $p<0.05$) and CZ, C3 and C4 were significantly activated to action-related sounds through a 62-ch speakers (CZ: t=4.83, C3: t=3.09, C4: t=1.84, $p<0.05$).We do not found a significant difference between action-related and non- action-related sounds through a 1-ch speakers but we found a significant difference between action-related and non- action-related sounds through a 62-ch speakers at CZ and C3 (CZ: t=3.63, C3: t=2.36, $p<0.05$). The mirror neuron system were activated in a three-dimensional sound reproduction system.
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