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Brain rhythm changes during singing voice perception

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ABSTRACT

Background

It has been observed that seeing a movement carried out by another human being activates motor or pre-motor areas in the observer's brain – a hallmark of the mirror system. In the same way, evidence of motor activations during discrimination tasks involving action sounds, speech or musical sequences have been reported. Thus, perceiving an action-related sound would provoke a mirror-like cerebral activity in the listener, as if they themselves were producing this action. In addition, it is known that for visual stimuli, this mirror activity is stronger for human movements than for non-human movements.

Aims

The aim of this study was to investigate whether the perception of a singing voice induces a specific motor activity compared to a computer-generated melody, and to determine the behavioral consequences of this motor resonance in a singing repetition task.

Method

Twenty participants were asked to listen to and vocally reproduce computer-generated and sung melodies. The computer-generated sound was built by superposition of the fundamental frequency and 3 harmonics, using a triangular wave, with an envelope of 5ms-rise and fall time.We recorded both the electrical activity using electroencephalography (EEG) and the vocal productions of participants. An acoustical analysis enabled us to get the mean vocal pitch accuracy of each participant. Then we analyzed the evolution of beta-motor (20Hz) and mu (10Hz) brain rhythms during vocal production and perception periods, two rhythms that are typically suppressed during motor activity.

Results

Our results showed that mu and beta were suppressed during singing, but also during perception of sung melodies, indicating an early sensorimotor activity during listening to voice. No such sensorimotor activity was found for computer-generated melodies. Finally, we found that motor resonance was inversely proportional to participants' vocal accuracy.

Conclusions

The motor activity we found during sung melody perception could reflect a mental simulation of the heard singing action. Natural singing voice perception in an imitative context would thus cause an activation of the auditory mirror system, as described for speech perception. As articulation was strongly reduced in the sung stimuli we used, we can conclude that phonatory gesture is by itself an action that can be mapped into bodily representations. The specificity of a sung melody, among other musical stimuli, is thus to be associated to specifically strong biomechanical representations in the listener. Our results suggest also that poor singers rely more strongly on these representations than good singers when encoding a melody.

Keywords

Singing voice – perception – pitch accuracy – mirror system – EEG