Cortical oscillatory signal correlates of action loudness and movement amount

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There is some evidence that the auditory cortex is activated during the processing of words referring to animal and object sounds as well as to other actions with acoustic features. The present study further examines whether processing words characterised by different levels of loudness such as loud (e.g., to shout) and quiet actions (e.g., to whisper) differentially activate the auditory cortex.

Twenty healthy participants were measured with MEG while semantically processing visually presented verbs. The two conditions were matched for length, word frequency, bi-/trigram frequency, and for number of facial vs. limbs/whole body actions. Verbs were followed by a short 440 Hz tone of stable sound pressure level after a time-interval of at least 600 ms to identify possible word-dependent loudness effects on the tone-related N1 amplitude. To determine brain regions of interest and loudness-related oscillatory patterns, a separate task requiring the processing of loud and quiet tones was used. The resulting temporal Brodmann areas A22, A41/42, and posterior superior temporal sulcus, which showed stronger alpha suppression following loud compared to quiet tones, were inspected in the word paradigm. Here, an analogous oscillatory pattern emerged consisting in stronger beta suppression following loud compared to quiet actions in the left hemisphere. In line with this, the tone-related N1 showed smaller amplitude after loud than quiet actions in the left but not in the right hemisphere, which hints at N1 suppression as observed after repetitive presentation of a tone. Differential auditory cortex recruitment depending on action loudness points to possible selective auditory simulation mechanisms involved in verb processing.

Additional analyses addressed high versus low movement amount as determined by means of a rating study (N=30). This served to disentangle effects of action loudness from a possible contribution of body- and object-related movement amount. While actions implying higher movement amount induced stronger beta suppression in the right V5/MT, no effect in the selected right or left auditory areas emerged. This suggests that loudness and movement amount are two independent processes, the first selectively engaging left auditory areas and the second the right motion area.