Differential Neuromagnetic Mismatch Responses to Spoken Action and Abstract Verbs in the Motor Cortex

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SUBMISSION DETAILS

Background: The role of modality-specific sensorimotor brain neural networks in higher-order cognition is a hotly debated question that remains unresolved. Studies that employ spatiotemporally precise neuroimaging tools such as MEG might potentially shed light onto this question and offer valuable techniques for translational research of various motor and cognitive disorders.

Methods: We developed a novel paradigm using mismatch negativity (MMN) to investigate cortical responses elicited by auditory presentation of semantically different verbs: abstract and motor action-related. Three experimental conditions used disyllabic Russian spoken words and acoustically similar pseudowords that were carefully matched to the main acoustic and linguistic variables. All stimuli had the divergence point at 250ms. Two motor action verbs (hand- and leg-related) and one abstract verb were used as deviant stimuli, pseudowords were used as standard stimuli. Neuromagnetic responces of twenty-six healthy subjects (mean age 20.5 y.o, 17 females) were recorded using a 306-channel Vectorview MEG system (ElektaNeuromag) in a passive non-attend oddball paradigm.
Source localization was done using L2-MNE loose constraints approach with individual sMRI-based Overlapping spheres models. Human Brainnetome Atlas (Fan, 2016) was used to study the source time courses within the hand and leg areas individually. To compensate for signal leakage from adjacent areas, the signal within each ROI was corrected for the averaged source activities from the inferior parts of the motor cortex. The resulting source time courses were compared using paired permutation t-tests.

Results: We found that in the MMN time window each motor verb elicited a greater response in the semantically relevant area of the primary motor cortex. Moreover, in each of the ROIs the abstract verb caused smaller source amplitude than both motor verbs ($p<0.05$), regardless of their semantic relation to the particular motor areas (Figure1)).

Conclusions: These findings demonstrate that semantic features of spoken words elicit different MMN responses in motor cortex: the abstract verb presentation was not specifically associated with

any of the studied cortical motor areas in contrast to the motor verbs presentation. The result extends the previous findings (Shtyrov, 2014) and supports the embodied cognition framework claiming modality-specific area involvement in words comprehension. Particularly, it allows us to disentangle brain networks involved in action-related and abstract language semantics processing. It might be further used to study language dysfunctions in a variety of populations with motor and language deficits.

Figures (JPG, PNG, GIF) Fig1.png

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