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## Neural Activation to Actions Performed with Hands and Legs – Real Movements versus Action Verb Reading

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The primary motor cortex seems to be involved not only in actual movements but also in understanding the concept of movements delineated by words (Hauk et al., 2008).

In this study we compare evoked responses in the sensorimotor cortex during actual movements and silent reading of action verbs using whole head magnetoencephalography (MEG) in 15 healthy subjects. In separate blocks participants had to perform alternating self-paced brisk extensions of their left and right hands and feet, respectively. The corresponding muscular activity was recorded above both forearms and shins using electromyography (EMG). In the lexical decision task different words were presented visually: hand/arm verbs (e. g. *greifen*) representing a movement of the upper extremity, foot/leg verbs (e. g. *laufen*) representing a movement of the lower extremity, and non-body verbs (e. g. *wünschen*) which do not imply a movement of any body part. In two questionnaire studies prior to our main experiment about 300 verbs were rated by 30 participants regarding imageability, familiarity and the association of a specific body part. According to the ratings, 48 verbs per category (hand, foot, non-body) were matched as regards length, frequency, imageability and familiarity. In the MEG study, these verbs were randomly presented twice, i. e. subjects silently read 96 verbs per category. Intermingled with these verbs we presented additional verbs and pseudoverbs (total amount was 20%) constituting the lexical decision task. Participants were asked to decide whether the presented word was a real word or a pseudoword by responding with eye movements either to the left or to the right as indicated by an arrow following the word. Eye movements were recorded using electrooculography (EOG) and gaze direction for real and pseudowords changed randomly. These trials were just analysed for correctness, but not as regards brain activity.

For data analysis we averaged evoked responses of the brain to onsets of hand and foot movements as measured with EMG and to visual word onsets. We used the equivalent current dipole source modeling technique (Hämäläinen et al., 1993) to identify the motor field (MF) and the movement evoked field I (MEF I) for hand and foot movements (Kristeva-Feige et al., 1994). Anatomical magnetic resonance images (MRI) of the brains were recorded to transfer functional data to individual anatomy in 14 subjects. Preliminary data for two out of 15 subjects clearly show a somatotopic localization of the hand and foot MF and MEF I dipoles in the sensorimotor cortex. We used these dipolar hand- and foot-sources to evaluate if neuronal activation to verbal stimuli could be explained.

We found that movement related sources were activated in the hand and foot verb conditions bilaterally between 150 and 500 ms after word onset, which was less evident after non-body verb presentations. Additionally, in the two subjects we found the tendency that these dipolar sources were specifically activated in the effector related verb conditions. That is, dipolar sources of hand movements partially explained cortical activation following presentation of hand verbs but not that much following foot verbs, whereas dipolar sources of foot movements explained activity following presentation of foot verbs but not that much following hand verbs.

We hypothesize that the analysis of further data will show a distinction between body related and non-body related activation as in the presented subjects as well as specific activation in the effector related verb conditions. This study serves as foundation for following studies investigating prefixed hand- and foot-action verbs.

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Kristeva-Feige, R., Walter, H., Lütkenhöner, B., Hampson, S., Ross, B., Knorr, U., Steinmetz, H. & Cheyne, D. (1994). A Neuromagnetic Study of the Functional Organization of the Sensorimotor Cortex. *European Journal of Neuroscience* 6, 632-639.