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# Decoding of two hand grasping types from EEG

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*Introduction:* Arm and hand movements are essential for performing activities of daily living (ADL). As a result, people with severe motor disabilities would greatly benefit from hand neuroprostheses for restoring grasping capabilities. Non-invasive prostheses mostly rely on EEG correlates of reaching, such as anticipatory potentials for movement initiation [1] or sensorimotor rhythms for movement execution [2]. In this work, we report EEG correlates for two different grasping types and the feasibility of performing reliable detection in single trials.

*Methods:* Ten subjects (1 female, mean age 27 years) participated in the recording. At the beginning of each trial, subjects rested their dominant (right) hand on a button on the table. Whenever they wanted (but waiting at least 2 seconds after the previous trial), they performed a movement to reach and then grasp the object placed at around 50 cm of distance. The object could be grasped in two different ways: power and precision pinch grasp. The type of grasping was freely chosen by the subject at each trial. After grasping the object, subjects were instructed to lift it, place it back to its original position and move back their hand to the rest position. Every 100 trials, the object was repositioned to a different place in order to avoid any laterality confounds. Subjects were asked to restrain eye movements or blinks during the reaching and grasping states. Approximately 400 trials per subject were recorded (~200 per grasping type). Trials where the rest phase lasted less than 2 seconds (around 5% of the total number) were removed from the analysis. Grasping onsets were synchronized with the EEG by means of hardware triggers generated when the user grasped the object (see Fig 1.a).

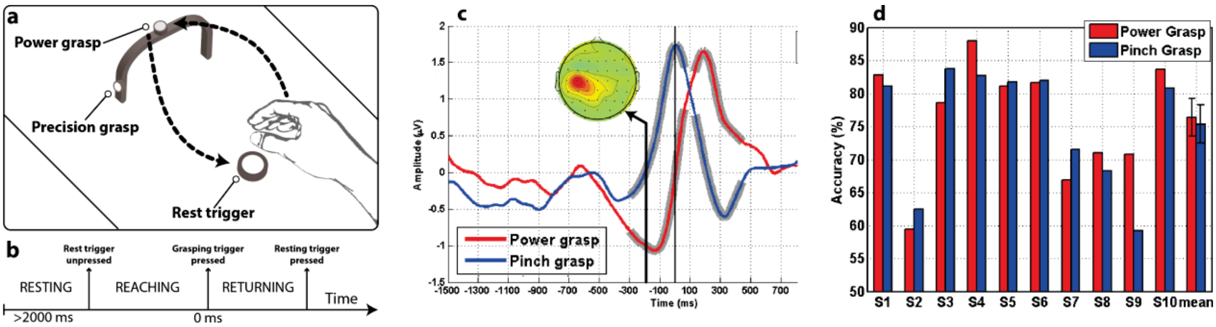


**Figure 1.** *(a) Schematic illustration of the setup. (b) Timeline of a single trial. 0 ms indicates the onset of grasp. (c) Grand averaged EEG at channel C3 for both types of grasp, where 0 ms indicates the onset of grasping, together with a topographic interpolation of the difference between the two conditions at -200 ms. (d) Ten-fold clasification accuracies of power vs precision grasps across all subjects.*

*Results:* EEG was recorded using a BioSemi system with 64 electrodes and non-casual filtered in the [1-6] Hz following previous results with ECoG [3]. EOG activity was removed using a regression algorithm 4]. Fig. 1c shows the grand averaged signals across subjects on channel C3 (contra-lateral motor cortex). Signals for the two grasping types were significantly different ($p<0.01$, Bonferroni corrected t-tests) as early as 300 ms prior to the grasping onset, and differences could be found up to 500 ms after grasp. The topographic representation of the difference between the two conditions revealed a very focal activation in the contra-lateral motor cortex, as expected by the nature of the task performed [5]. To discriminate between the two grasping types, a linear discriminant was trained on 8 contra-lateral motor channels using the activity prior to the grasping onset ([-500, 0] ms). Grasping types were detected with an accuracy of $75.90 \pm 5.02\%$ on average across subjects (Fig. 1d).

*Discussion:* We report for the first time the existence of EEG correlates for two different grasping types. Importantly, reported results are in line with similar works using semi-invasive signals [3], yet with slightly lower accuracies. Further experiments will confirm the decoding of these correlates on closed-loop scenarios.

*Significance:* Decoding of grasping types in single-trials using EEG is possible, which could lead to a new generation of neuroprostheses capable of executing different high-level commands based on the user needs.

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