Decoding reach-and-grasp actions from human low frequency EEG

Andreas Schwarz[1], Patrick Ofner[1], Joana Pereira[1], Andreea I. Sburlea[1] and Gernot R. Müller-Putz[1]
andreas.schwarz@tugraz.at, ***gernot.mueller@tugraz.at***
[1]*Institute of Neural Engineering, Graz University of Technology, Austria*

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Introduction

Despite the high number of degrees of freedom of the human hand, most actions of daily life can be executed incorporating only **palmar, pincer and lateral grasp**. In this study we **attempt to discriminate** these three **executed reach-and-grasp actions** utilizing their **EEG neural correlates**. Ultimately, we target to incorporate these findings in a Brain-Computer Interface (BCI) driven neuroprosthesis which should enable persons suffering from high spinal cord injury to perform basic grasps of daily life [1].

Methods

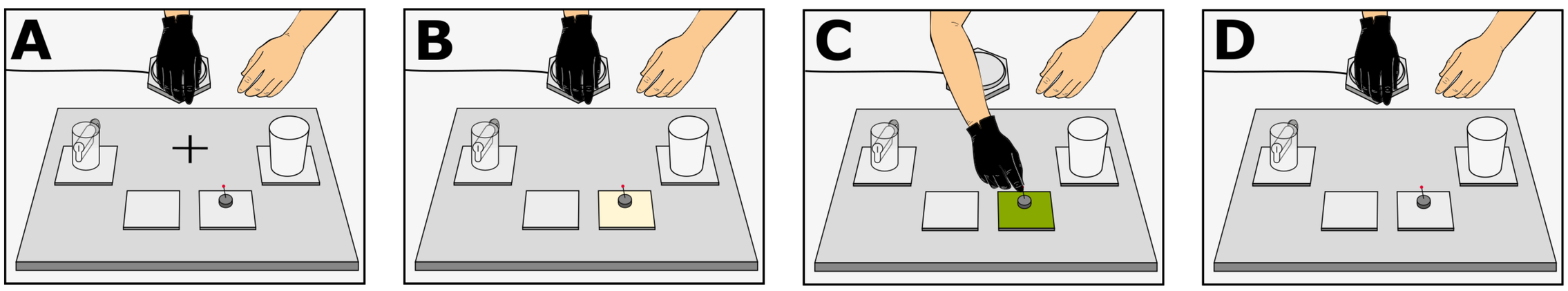

Figure 1: Paradigm: (A) Participants were instructed to rest the hand comfortably on a pressure button. At second 0, a cross appeared on the screen to focus users' attention. **(B)** At second 2, one of the objects was highlighted in white for a random time period (1-1.75s). **(C)** As soon as the highlighting turned green, participants performed the reach-and-grasp tasks and held the object as long as the green highlighting remained. **(D)** Thereafter, participants returned their hand to the pressure button.

In a cue-guided experiment (see Figure 1), 15 healthy individuals were asked to perform reach-and-grasp actions using daily life objects. We recorded 72 trials for each reach-and-grasp condition and from a no-movement condition. In an offline multiclass classification scenario (10 x 5 crossvalidation), which incorporated not only all reach-and-grasp actions but also the no-movement condition, we used a window of 1000 ms for extracting time domain features.

Results

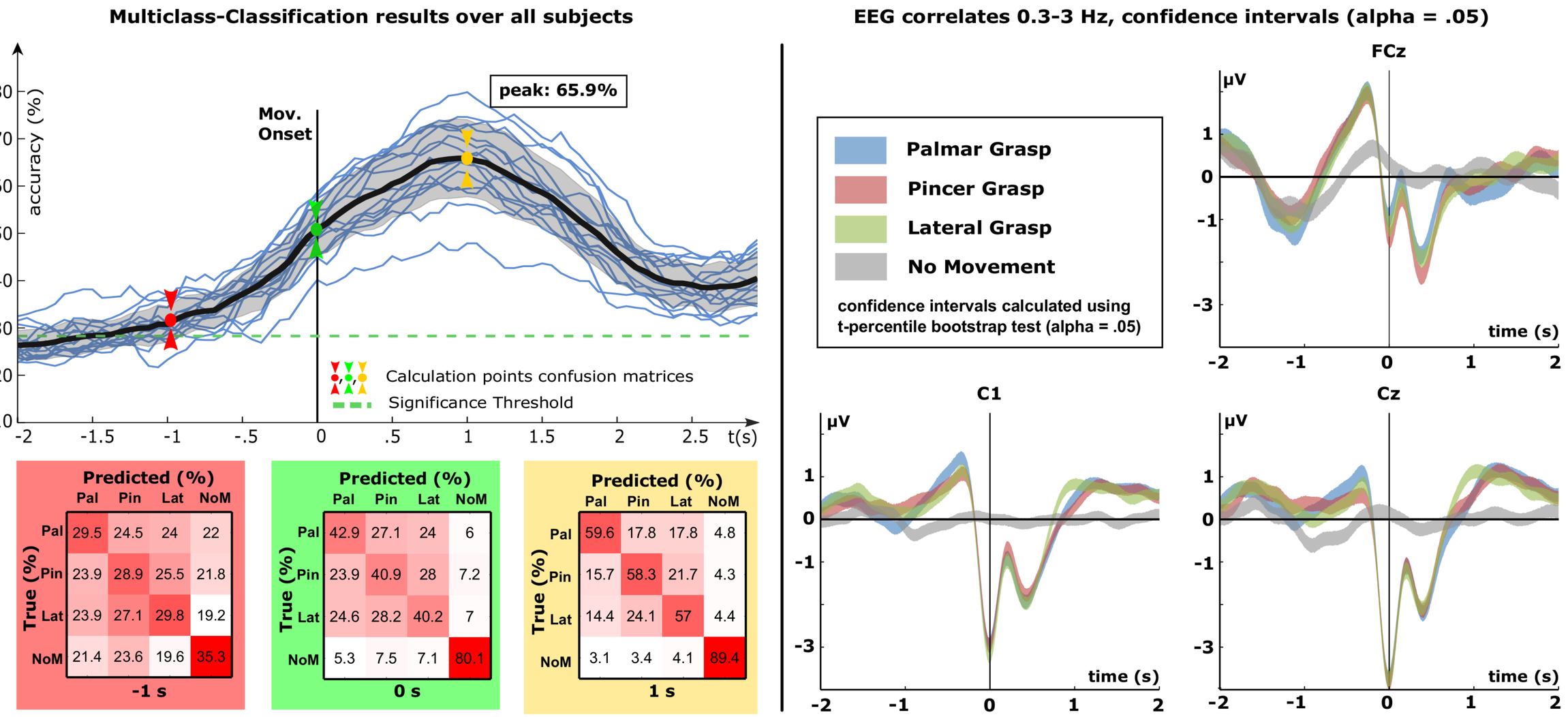

Figure 2: LEFT: Multiclass classification results. The top left plot displays the grand average classification performance including its standard deviation and subject-specific results (blue). Colored marker represent calculation time points for the subjacent confusion matrices. Confusion matrices are normalized by row and display rates in percentage. **RIGHT: Movement-related cortical potentials (MRCPs)** with respect to the movement onset for all conditions. Color shaded areas show the confidence interval of the designated grasp (alpha = .05)

Conclusion

In this study we showed that it is possible to discriminate three executed reach-and-grasp actions prominent in people's everyday use from non-invasive EEG. Based on their neural correlates, we could show differentiation against each other and also against a no-movement condition. Furthermore, we identified significant differences in the underlying movement-related cortical potentials.

References

1. Müller GR, Schwarz A, Pereira J, Ofner P. From classic motor imagery to complex movement intention decoding: The noninvasive Graz-BCI approach. *Progress in brain research*, 228 39-70, 2017.

Acknowledgments

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