

INTRODUCTION

In a typical Sternberg task (Sternberg, 1966) the participant is presented with a succession of digits to remember but does not know how many digits will be presented on a given trial. This uncertainty may influence the readiness to shift from encoding to maintenance mode once maintenance period starts. As more digits are presented the probability of maintenance period onset increases and the uncertainty is reduced.

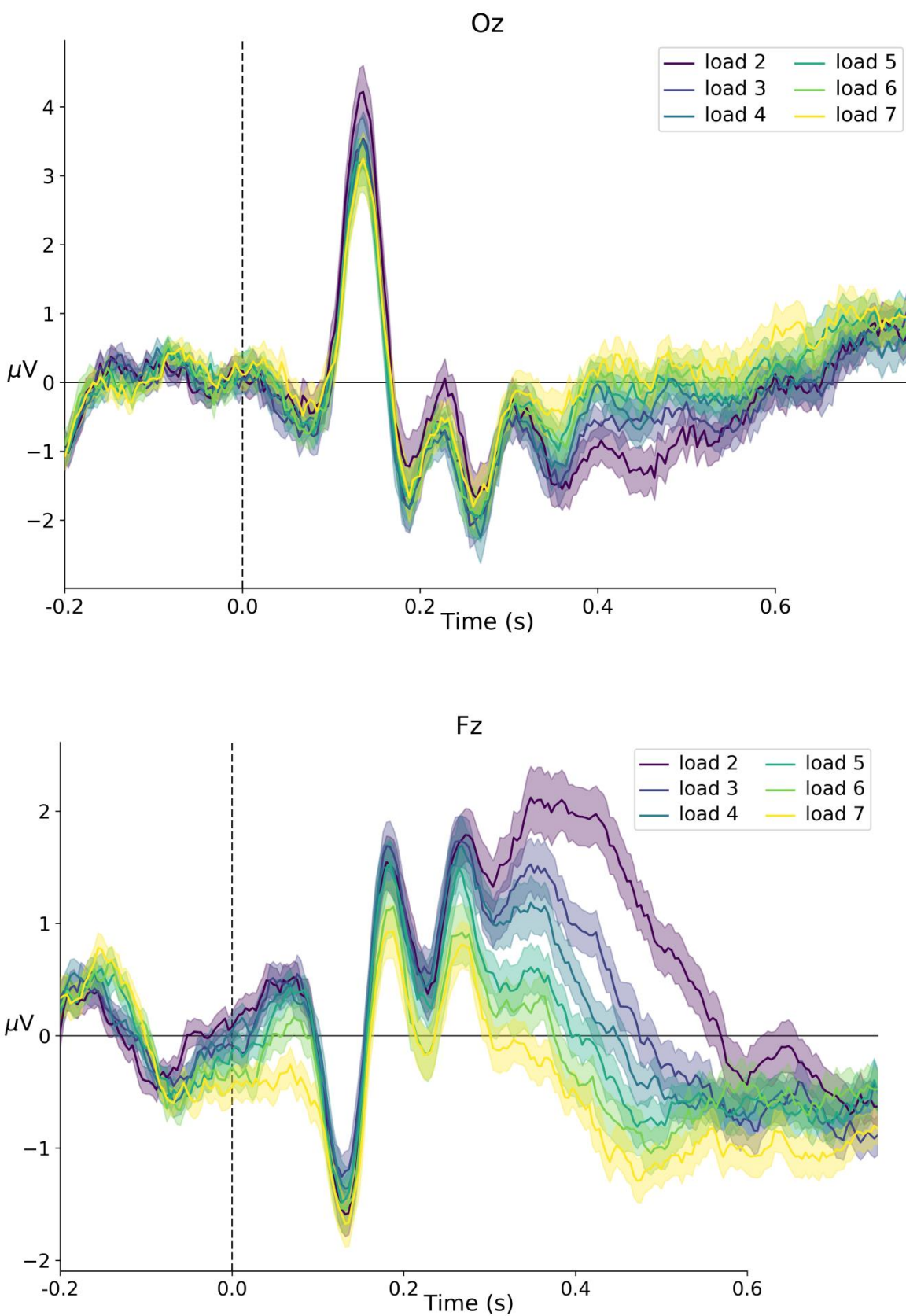
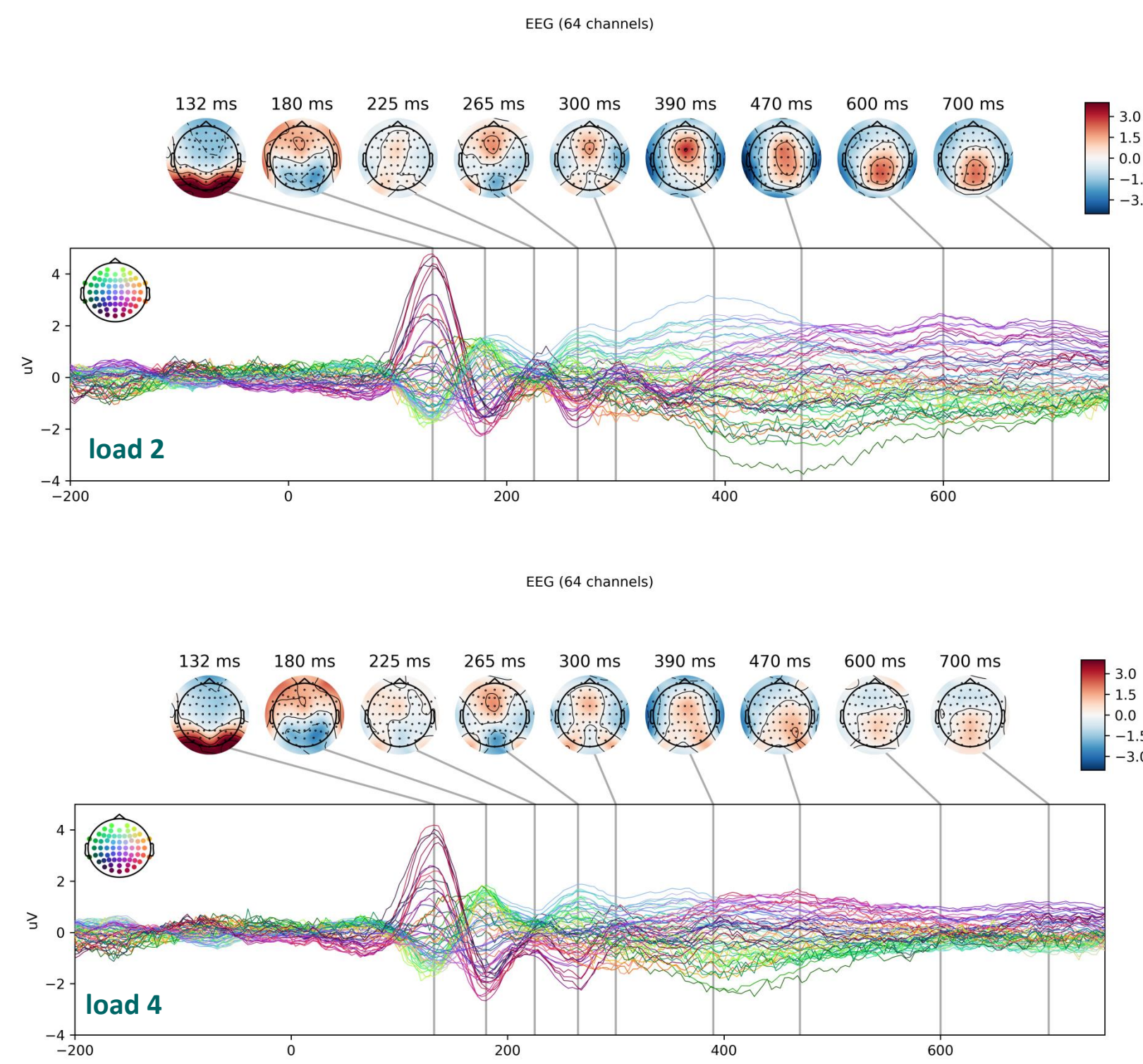
Therefore if maintenance period starts early the participant has to exert more cognitive control to switch to maintenance mode. In line with this reasoning a recent study (Kaminski et al., 2017) found that maintenance neurons in the medial frontal cortex (MFC) show increased activity to early start of maintenance period. We investigate this phenomenon with EEG.

METHOD

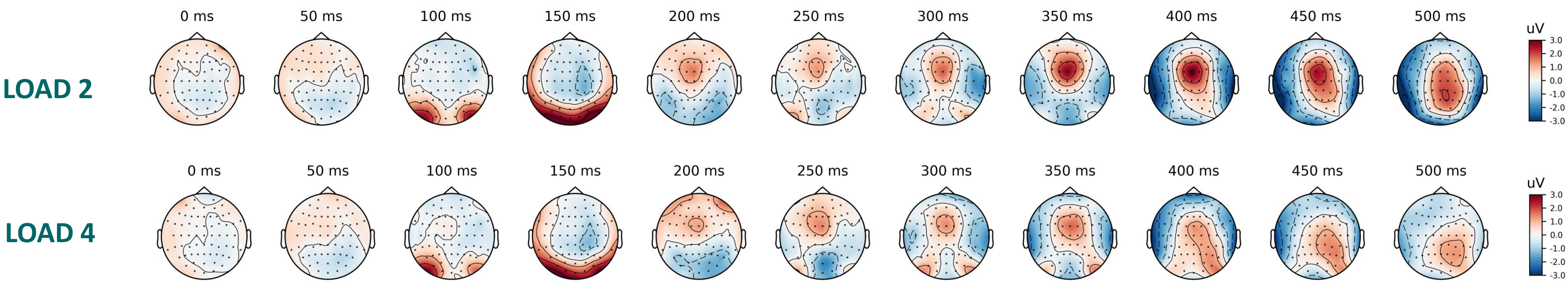
Fifty eight participants (aged 18-35) performed Sternberg task with 6 memory loads (from 2 to 7 digits to remember) when EEG was recorded. All digits were presented in fast succession (one digit every 0.5 seconds) and appearance of fixation dot

started the maintenance period (which lasted randomly from 1.5 to 2.5 seconds). We compared event related potentials locked to the onset of the fixation dot separately for different loads.

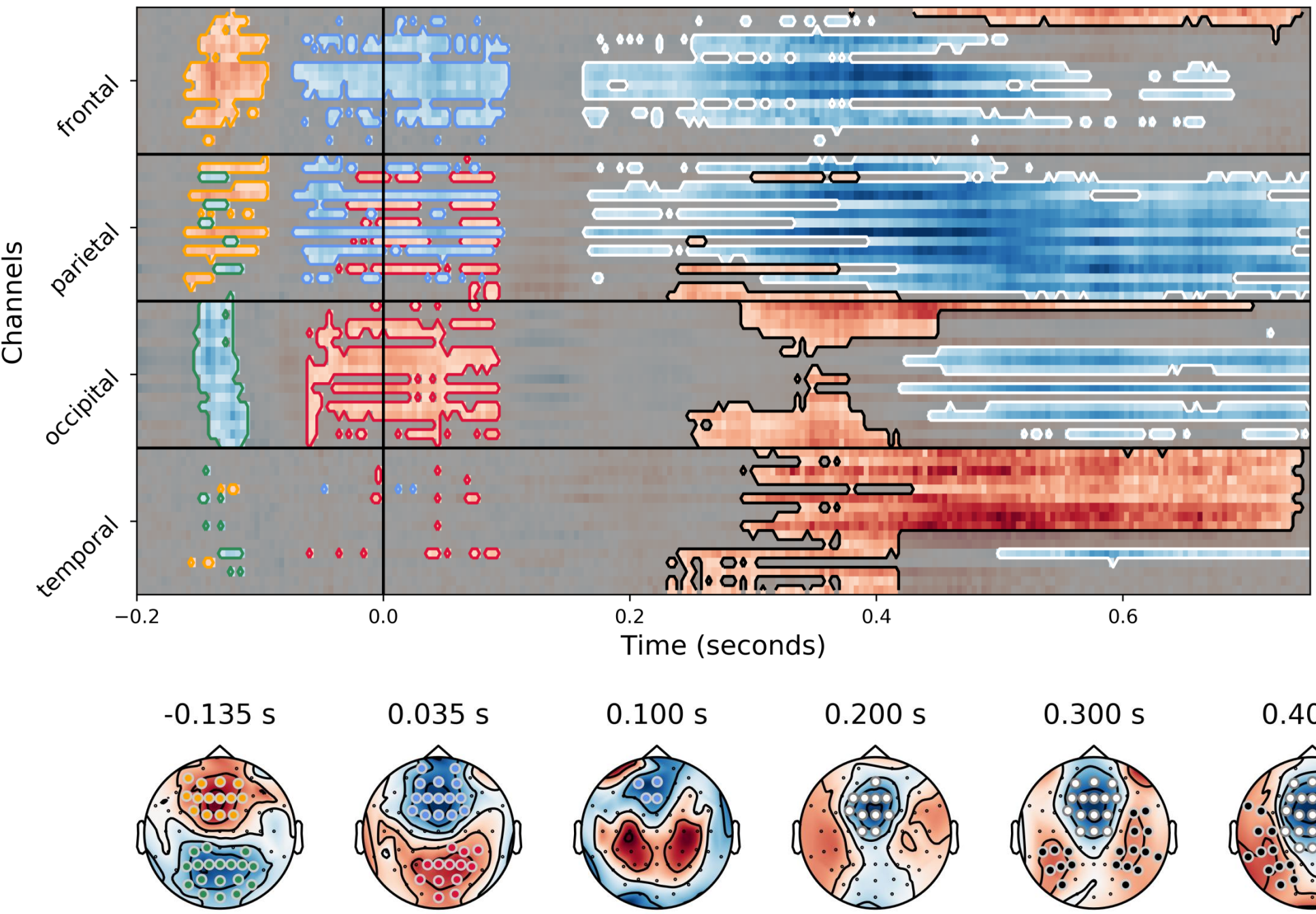
RESULTS



RESULTS



Linear changes with load (2,3,4,5,6,7)



We observe that late midline frontal ERP response to maintenance start strongly depends on how early encoding period ends - displaying a significant cluster with negative relationship with load that starts around 250 ms after maintenance onset and continues at least up to 500 ms. The topography of this effect resembles the topography of midline frontal theta power in earlier stages (300 - 400 ms after maintenance onset) and later progressively shifts towards posterior regions (400 - 700 ms).

CONCLUSIONS

We interpret this result as a manifestation of increasing readiness to switch from encoding into maintenance phase with increasing load. Therefore fixation dot signalling the onset of maintenance is increasingly expected with successive digit presentations and bears less behaviorally relevant information. The timing and topography of this effect is similar to the P300 response but is better defined midline-frontally and prolonged. In our opinion earlier, less expected maintenance onset increases cognitive cost of switching from encoding to maintenance mode. Although our experiment was not designed to observe such costs behaviorally we see weak support of such interpretation in behavioral effects (table on the right): shorter maintenance leads to longer reaction times in load 4 as if more time was needed to switch from encoding to maintenance.

	Estimate	Std. Error	df	t value	Pr(> t)	signif.code
(Intercept)	8.184e-01	3.151e-02	4.245e+02	25.969	< 2e-16	***
Isin	-8.267e-02	2.633e-02	2.552e+03	-3.140	0.00171	**
waitTime	-3.633e-04	1.750e-04	2.101e+03	-2.076	0.03803	*
isin:waitTime	3.721e-04	1.687e-04	2.552e+03	2.206	0.02747	*

Linear mixed effects model showing significant effect of maintenance length on reaction time for load 4

REFERENCES

- Bezanson, J., Edelman, A., Karpinski, S., & Shah, V. B. (2017). Julia: A fresh approach to numerical computing. SIAM Review, 59(1), 65-98.
- Gramfort, A., Luessi, M., Larson, E., Engemann, D., Strohmeier, D., Brodbeck, C., Parkkonen, L., Hämäläinen, M. MNE software for processing MEG and EEG data, NeuroImage, Volume 86, 1 February 2014, Pages 446-460, ISSN 1053-8119
- Kaminski, J., Sullivan, S., Chung, J. M., Ross, I. B., Mamelak, A. N., & Rutishauser, U. (2017). Persistently active neurons in human medial frontal and medial temporal lobe support working memory. Nature Neuroscience, 20(4), 590-601.
- Sternberg, S. (1966). High-speed scanning in human memory. Science, 153(3736), 652-654.



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<https://github.com/mmagnuski/ICON2017-poster>

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