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Misspelled-word reading modulates late cortical dynamics

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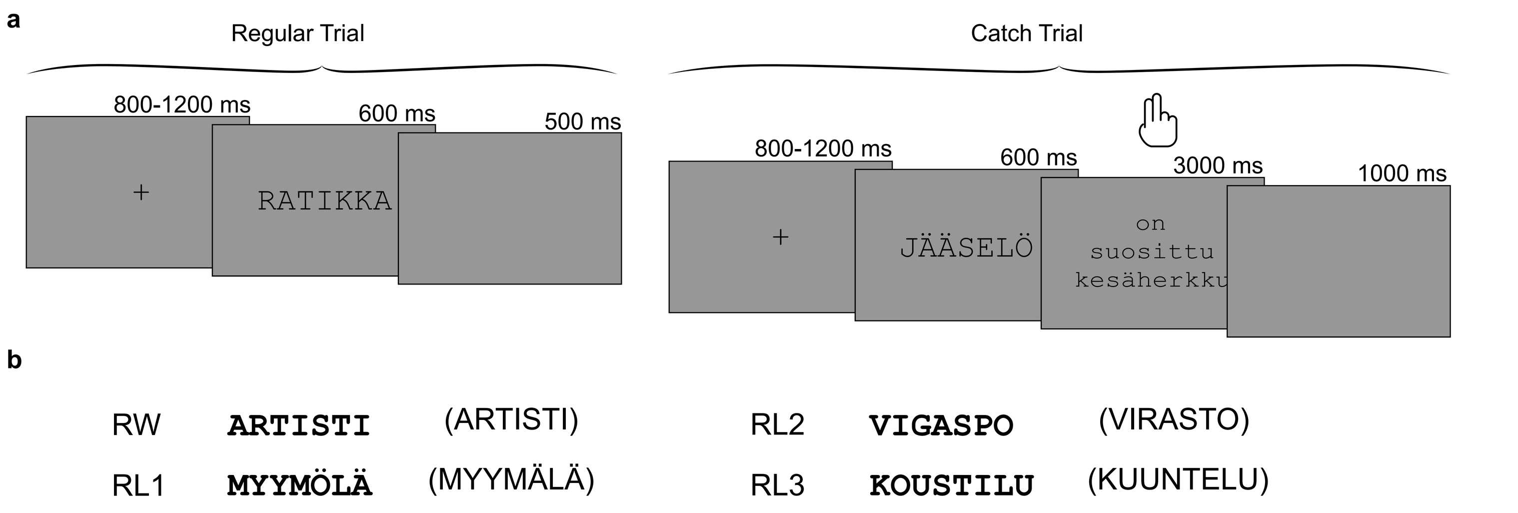
INTRODUCTION

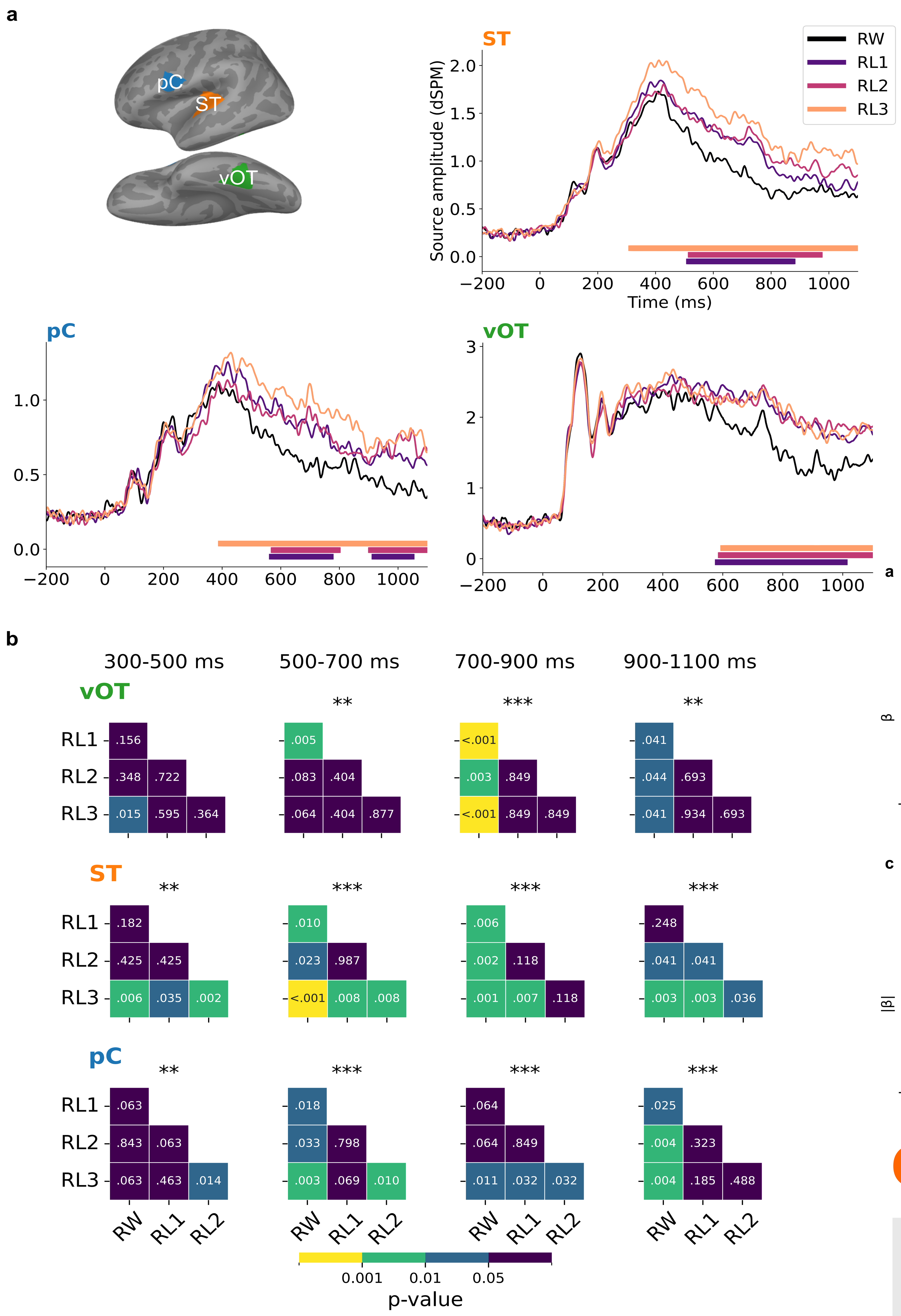
We sometimes readily recognize misspelled words.
By systematically and parametrically varying the degree of misspelling, we investigated where and when brain responses diverged which determined whether misspelled words were resolved as real words or not using behavioral data and MEG.

METHODS



▲ **Fig. 1: a**, During regular trials, participants engaged in silent reading of the presented stimuli, whereas in catch trials, participants were required to make a behavioral response on sentence validity ("MYSTYGY fascinates the imagination"). **b**, Example stimuli from each of the four stimulus categories, along with their corresponding base words enclosed in parenthese.

Participants silently read the stimuli trying to recover their originally intended meanings (Fig. 1).
We compared the effect of misspellings on cortical evoked activation including the time courses in each ROI. Additionally, we performed a linear mixed effects (LME) analysis to model the evoked responses within the ROIs. The fixed effect in our model was number of replaced letters, and the random effect was the participants. We also examined visual distance (visual) and bigram frequency difference between stimulus and its base word (sublexical), as well as stimulus recognizability (lexical).

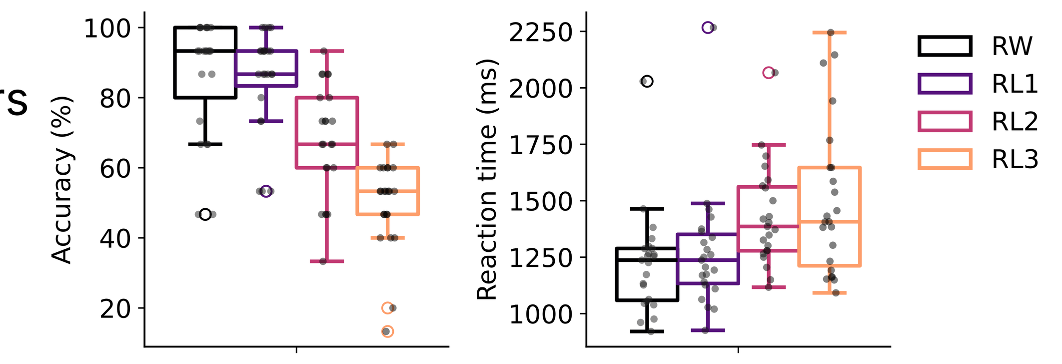


▲ **Fig. 3: a**, Regions of interest (ROIs) and averaged evoked responses of each category within the ROIs. **b**, Results of one-way repeated measures ANOVA andpairwise t-test (FDR corrected) between conditions in different time windows.

RESULTS

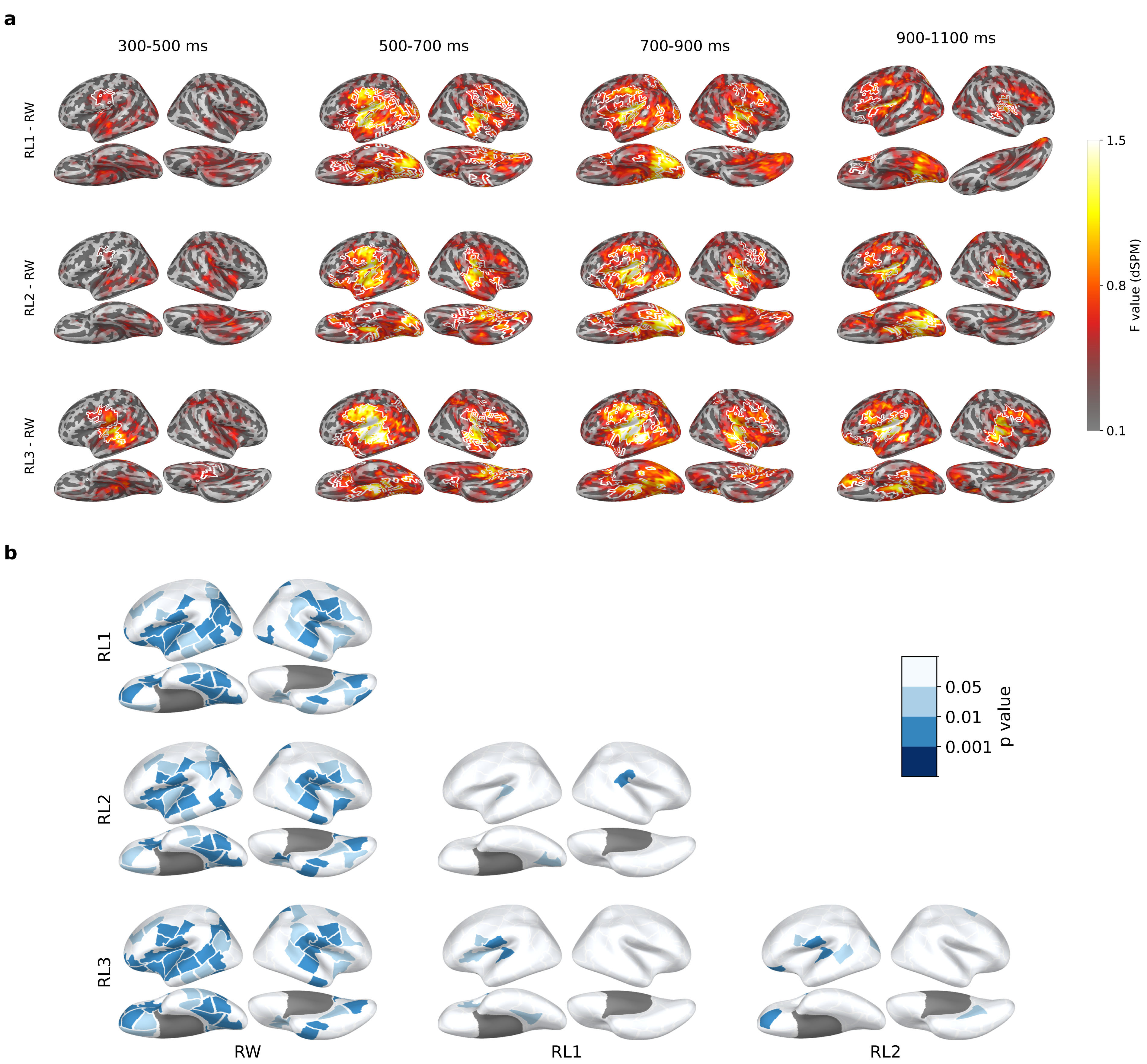
Behavioral

Task accuracy showed a decreasing trend with an increasing number of replaced letters (RW ≈ RL1 > RL2 > RL3 ≈ 50%).
Reaction times increased with an increasing number of replaced letters
(RW < RL1 < RL2 ≈ RL3)

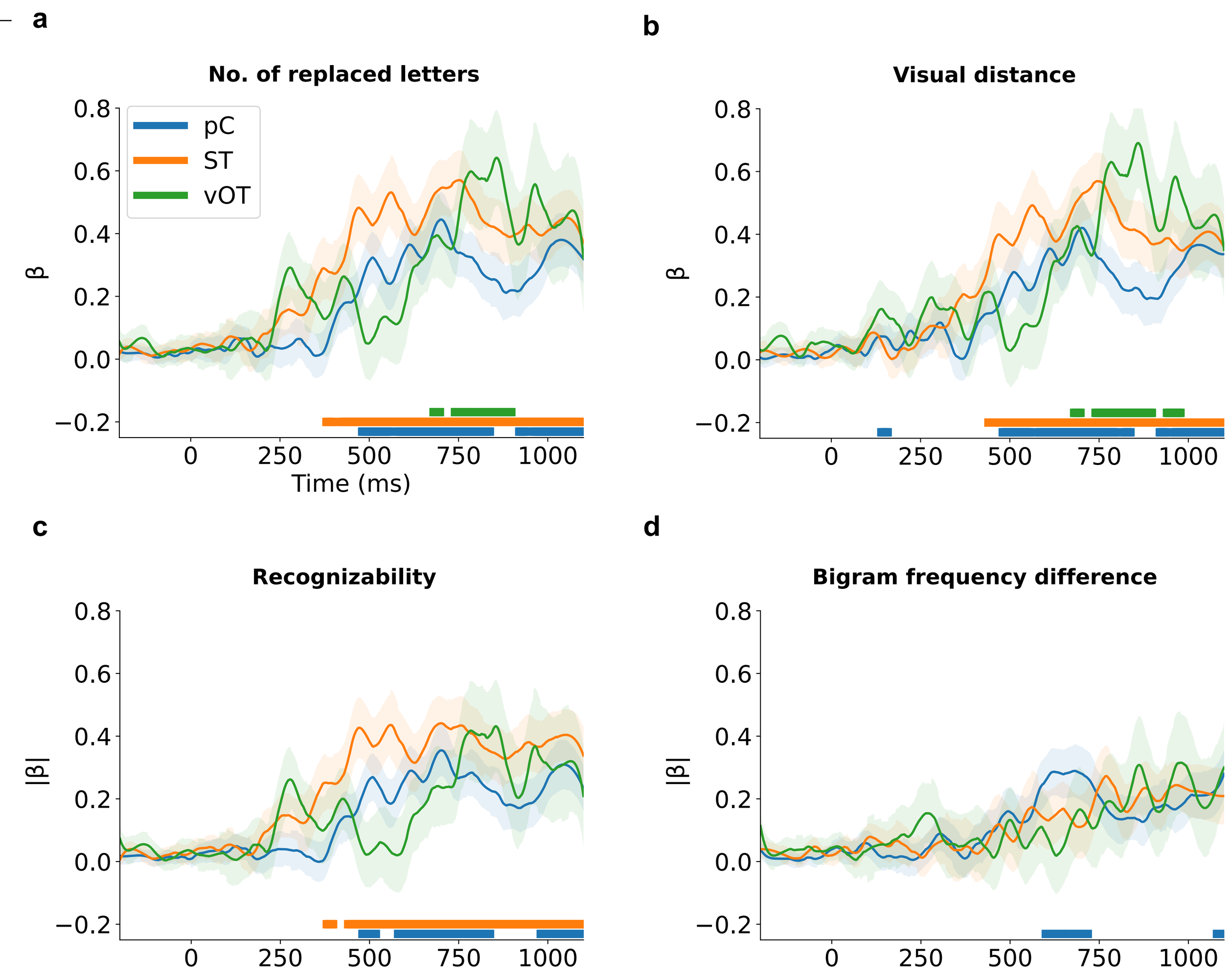


MEG

We identified three brain regions that were notably modulated by misspellings: left ventral occipitotemporal cortex (vOT), superior temporal cortex (ST), and precentral cortex (pC). Temporally, these regions showed fairly late and sustained responses selectively to misspelled words (Fig 2. and Fig 3.).
A linear mixed effects (LME) analysis further showed that pronounced and long-lasting misspelling effects appeared first in ST and then in pC, with shorter-lasting activation eventually observed also in vOT (Fig. 4).



▲ **Fig. 2**: Cortical activation evoked by misspelled words vs. real words. **a**, Group-level source estimates (MNE-dSPM) contrasting RWs and misspelled words in four selected time windows.White borders indicate clusters with p < 0.05 in a one-tailed cluster-based permutation test. **b**, Statistical tests on the evoked activity during 300--1100 ms between all pairs of conditions, with FDR-corrected p-values.



◀ **Fig. 4:** Time courses (LME, β ± s.e.) of misspelling sensitivity in terms of number of replaced letters (**a**), visual distance (**b**), bigram frequency difference (**c**) and recognizability (**d**). Solid bars indicate time regions of significant effect (p<0.01)

CONCLUSIONS

We found no rigid dichotomy, but rather a spectrum, between words and nonwords. Brain areas typically associated with the language network were engaged in a late and sustained process to disambiguate misspelled words from about 300 ms onwards. These results cannot be fully explained by a typical rapid feedforward mechanism. An anterior-to-posterior spread of misspelling information might imply the involvement of recurrent feedback and feedforward interactions during misspelled word processing.