National Research University – Higher School of Economics, Moscow, Russian Federation

Tatiana Malevich, Vadim Nikulin, Zafer Iscan, & W. Joseph MacInnes

Combining EEG and eye tracking: A joint experiment with the exogenous orienting task

Early facilitation of reaction time to the target presented at the validly cued location with a short cue-target onset asynchrony (CTOA) is a widely observed phenomenon accompanying exogenous orienting. However, its robustness and automaticity are sometimes called into question (MacInnes & Krüger, 2015; Malevich et al., 2016). Furthermore, a new account was proposed to explain it as a result of perceptual merging caused by interactions between feedforward & feedback projections (Krüger et al., 2014). Here we present preliminary results of a study designed to test the neuronal nature of cueing effects. We combined the behavioral cueing paradigm with examination of α-activity (8–12 Hz) that was shown to indicate a release from cortical inhibition resulting in facilitation of processing in voluntary orienting (Thut et al., 2006).

Hypothesis 1. Suppression of prestimulus α-activity over posterior regions covaries with faster manual reaction times (MRTs) under pre-cue condition

Hypothesis 2. Perceptual merging depends on neuronal states in the occipito-parietal cortex

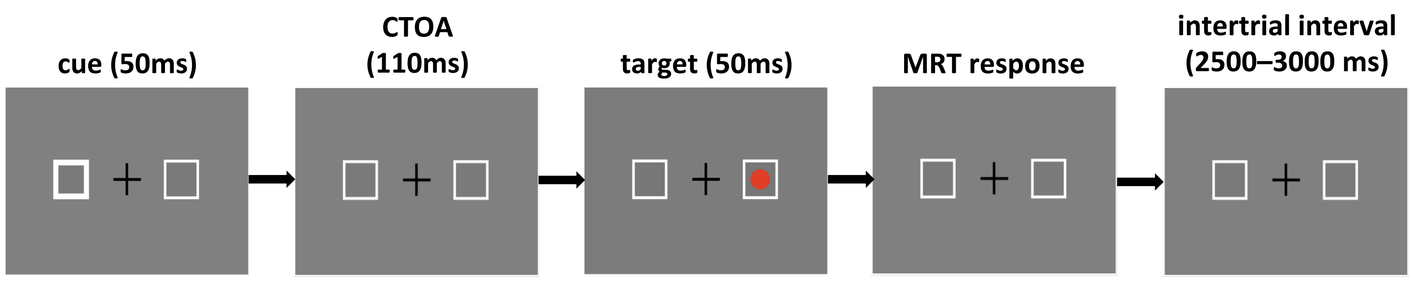


Figure 1. A structure of a trial (pre-cue invalid condition). Proportions are not preserved.

- MRT – speeded button response (Krüger et al., 2014)
- eye position controlled with eye tracking (SMI RED250mobile, 60 Hz)
- ongoing α-activity (8–12 Hz) recorded from the 64-channel actiCHamp system (1000 Hz, < 20 kΩ)
- 2 resting state recordings during breaks
- exogenous, non-informative cues
- validly vs invalidly cued locations
- pre-cued (cue prior to target) vs post-cued trials
- catch & neutral trials included
- 5 sessions, 1120 trials in total
- N = 20 (15 females, mean age = 25.6), 5 excluded

Results

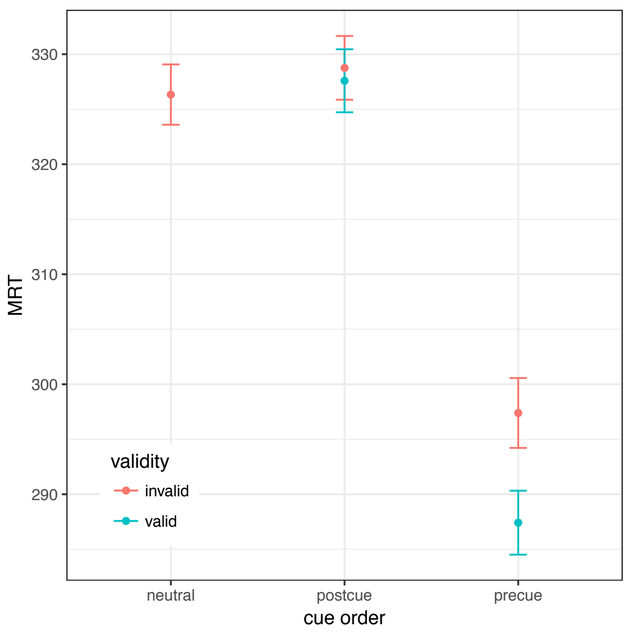


Figure 2. MRT results show facilitation but no evidence of perceptual merging. Valid pre-cue trials are on average 9.2ms faster (*SE* 2.7).

A number of saccades and their presence within the trial and /or within the intertrial inteval do not affect the results.

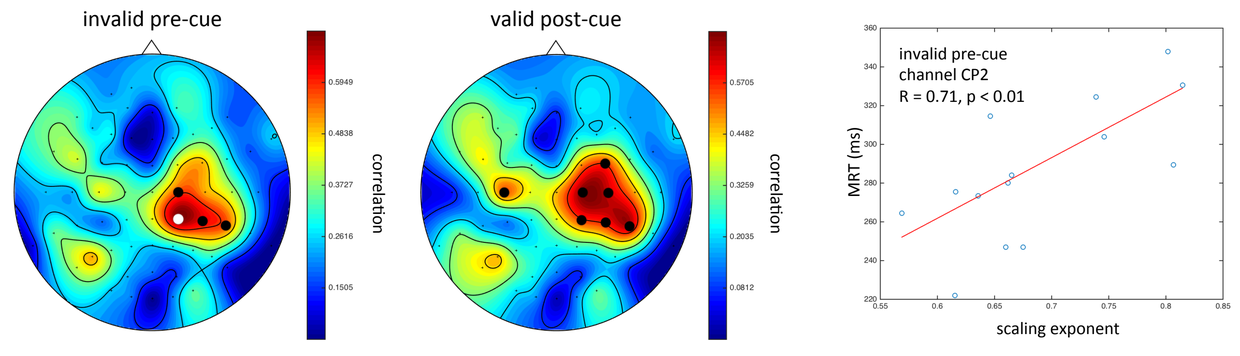


Figure 3. Neuronal dynamics was estimated with long-range temporal correlations (LRTC) in the amplitude of α-oscillations (Hardstone et al., 2012). Topographies show the strength of raw Spearman correlation between LRTC and MRTs during the 1st rest (8–12 Hz). Black dots indicate significant channels ($p < 0.05$). The white dot indicates the channel on the scatterplot. The effect does not differ across conditions. No effect was observed for the amplitude.

Figure 4. Exemplified topographies show correlations between (A) the amplitude and false alarm rate and (B) LRTC and false alarm rate during the 2nd rest (a raw effect). Black dots indicate significant channels ($p < 0.05$). The white dot indicates the channel shown on the scatterplot.

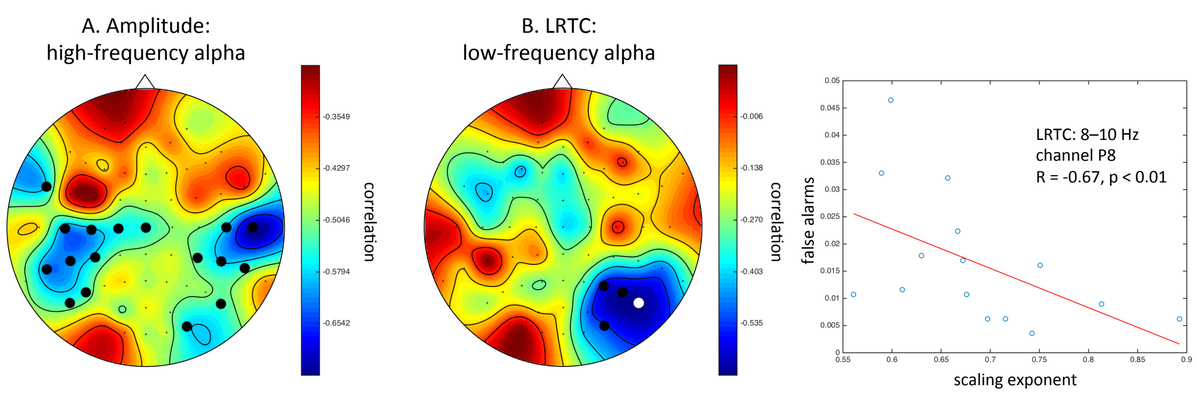
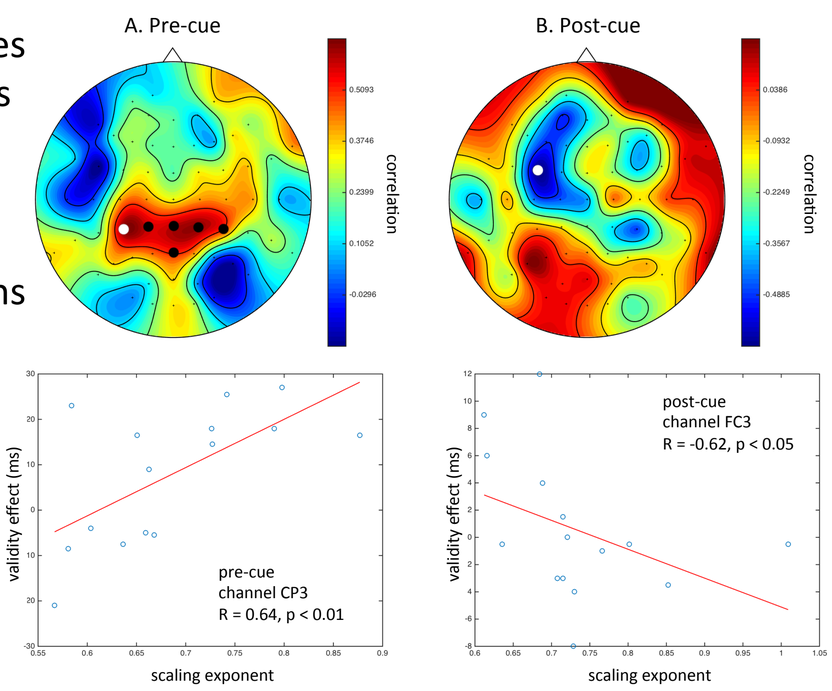


Figure 5. Topographies show raw correlations between LRTC and validity effect for the (A) pre-cue and (B) post-cue conditions during the 2nd rest (8–12 Hz). Black dots indicate significant channels ($p < 0.05$). White dots indicate channels on the scatterplots.



Discussion

- MRTs show robust facilitation but no evidence of perceptual merging.
- Lack of perceptual merging effect might be explained either by Type I error in the original experiment (Krüger et al., 2014) or by low power of the current data and / or neuronal specifics of the effect.
- Significant positive correlations of LRTC over right parietal regions with MRTs: the higher the scaling exponent, the slower the response.
- Correlations between LRTC and MRTs are not affected by conditions.
- Neuronal dynamics but not the amplitude might predict MRTs.
- Significant negative correlations of LRTC / α-amplitude with anticipatory responses: the higher the scaling exponent / amplitude, the less the false alarm rate.
- Validity effect might depend on neuronal dynamics: it correlates positively with LRTC under the pre-cue condition and negatively under the post-cue condition.

Contact: t.v.malevich@gmail.com

References

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