Poster # B2
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Decoding attention control and selection in young and older adults

Xiangfei Hong[1], Jiaqi Wang[2], Jianan Wang[2], Junfeng Sun[2], Jijun Wang[1], Chunbo Li[1], Mingzhou Ding[3], Shanbao Tong[2]

[1]Shanghai Mental Health Center, Shanghai Jiao Tong University School of Medicine, Shanghai, China

[2]School of Biomedical Engineering, Shanghai Jiao Tong University, [3]J Crayton Pruitt Family Department of Biomedical Engineering, University of Florida

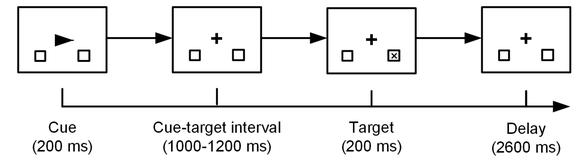
Introduction

- Attention control and selection can be decoded from multi-channel event-related potential (ERP) patterns during cued visual spatial attention tasks [1].
- The decoding accuracy during cue-target interval (attention control) predicted attentional modulation of target-evoked N1 amplitude, and the decoding accuracy during target processing (attention selection) predicted behavioral performance [1].
- Here we examined how normal aging impacted attention control and selection by decoding multichannel ERP patterns from healthy young and older adults during two cued visual spatial attention tasks.

Methods

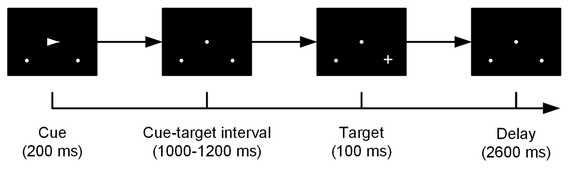
• Paradigm

(A) Experiment 1: Instructional cueing



Totally ignore and not respond to targets in the unattended visual field

(B) Experiment 2: Probabilistic cueing (~74% valid)



Respond to targets in ***both*** attended and unattended visual field

Figure 1. Two different cueing strategies of spatial attention task. Instructional cueing was applied in Experiment 1 and probabilistic cueing was applied in Experiment 2. Each subject was required to covertly orient attention to either the left or the right visual location via a cue, and make a button response as accurately and quickly as possible when the target presented later was a plus sign (50% probability).

• Data Acquisition and Analyses

- Exp 1: 30 young (21.3±1.9 yrs) vs. 20 older (62.4±7.5yrs)
- Exp 2: 26 young (22.0±1.0 yrs) vs. 31 older (67.3±5.7 yrs)
- 32- (Exp 1) or 64- (Exp 2) channel scalp EEG recording
- Multivariate pattern classification was performed for cue-related epochs (cue left vs. cue right) and target-related epochs (cued target vs. uncued target) using support vector machine with leave-one-out cross validation [2].
- Cue-related decoding accuracy was correlated with the magnitude of attentional modulation of target-evoked N1.
- Target-related decoding accuracy was correlated with behavioral performance (reaction time, RT).

References:

[1] Hong X, Bo K, Meyyapan S, Tong S, Ding M, (2020), bioRxiv, doi: 10.1101/2020.02.08.940213.

[2] Bae GY & Luck SJ, (2018), J Neurosci, 38(2), 409-422.

Behavioral Results

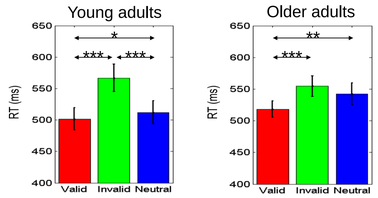


Figure 2. Behavioral performance in the Probabilistic cueing dataset. Both young and older adults showed classical behavioral (RT) cueing effects (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$).

Note that no behavioral cueing effects could be derived in the Instructional cueing experiment.

Decoding Accuracy

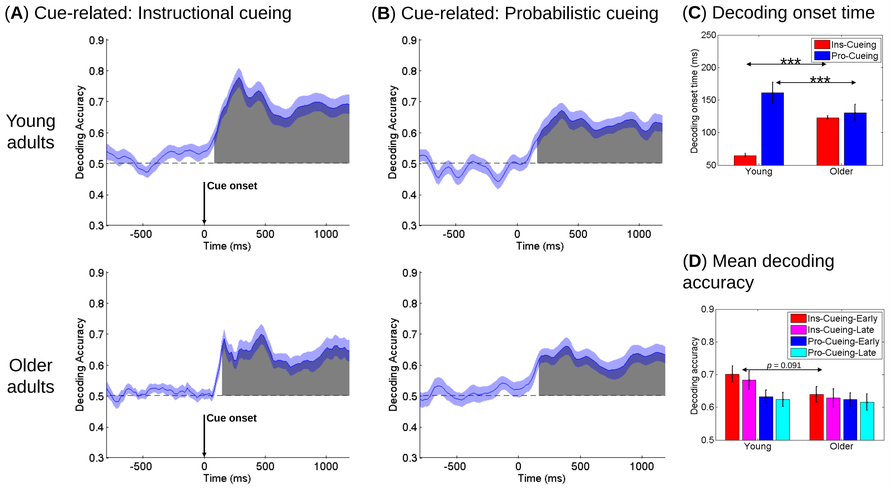


Figure 3. Mean accuracy of ERP-based multivariate decoding for cue-related neural processing (cue left vs. cue right) in the Instructional cueing dataset (***A***) and Probabilistic cueing dataset (***B***). Chance level performance (0.5) is indicated by the horizontal dash lines. Gray areas indicate clusters of time points in which the decoding was significantly greater than chance after the FDR correction for multiple comparisons. The blue shading indicates ±1 SEM. The comparisons of decoding onset time (***C***) and mean decoding accuracy (***D***) were shown on the right (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$).

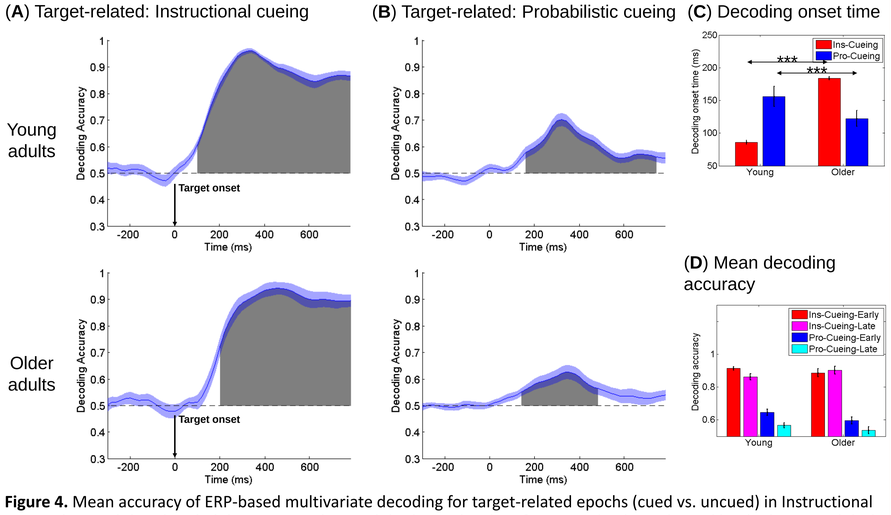


Figure 4. Mean accuracy of ERP-based multivariate decoding for target-related epochs (cued vs. uncued) in Instructional cueing dataset (A) and Probabilistic cueing dataset (B). Chance level performance (0.5) is indicated by the horizontal dash lines. Gray areas indicate clusters of time points in which the decoding was significantly greater than chance level after the FDR correction for multiple comparison problem. The blue shading indicates ±1 SEM. The comparisons of decoding onset time (***C***) and mean decoding accuracy (***D***) were shown on the right (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$).

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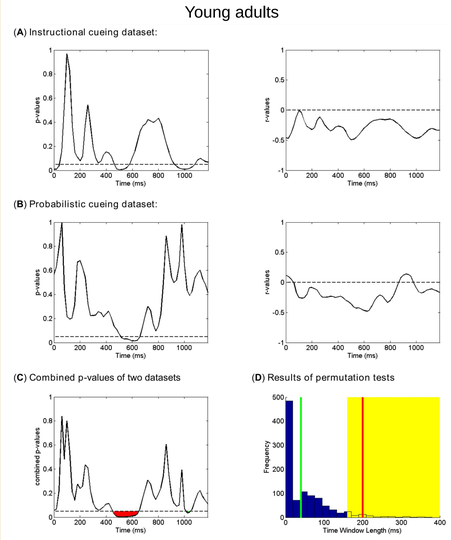
Correlation Results



No significant results.

Figure 5. Results of between-subject correlation between cue-related decoding accuracy and attentional modulation of target-related N1 in Instructional cueing dataset (***A***) and Probabilistic cueing dataset (***B***). The p values from the two datasets were combined by the Liptak-Stouffer meta-analysis (***C***). The p = 0.05 and r = 0 are indicated by the horizontal dash lines. Panel ***D*** shows the results of permutation tests for the two consecutive time windows identified in Panel ***C***. The null distribution was estimated from 1000 permutations of the data, by randomly pairing one subject's decoding accuracy with another subject's N1 modulation. If the window length from the observed data (red and green lines) falls within the top 5% of values from the null distribution (indicated by the yellow area), the observed window is considered to be significant.

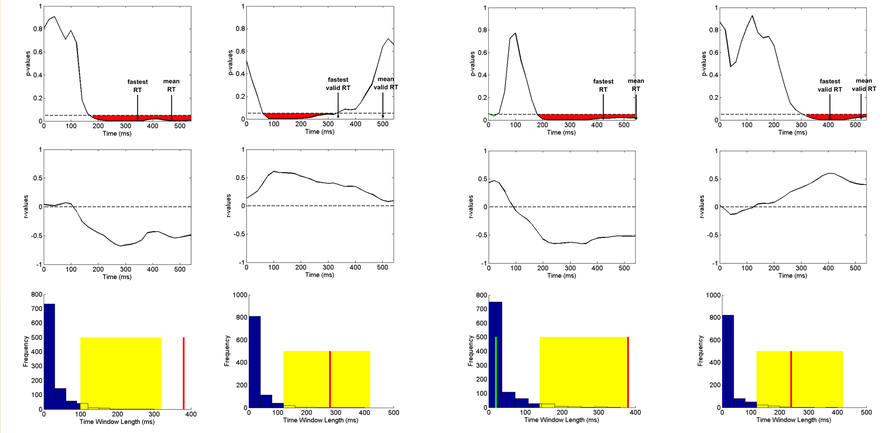


Figure 6. Results of between-subject correlation between target-related decoding accuracy and RT effects (***A***: RTs to attended targets; ***B***: invalid RTs minus valid RTs) in Instructional cueing dataset (***A***) and Probabilistic cueing dataset (***B***). The p = 0.05 and r = 0 are indicated by the horizontal dash lines. For each dataset, the null distribution was estimated from 1000 permutations of the data, by randomly pairing one subject's decoding accuracy with another subject's RT effect. If the window length from the observed data (red/green line) falls within the top 5% of values from the null distribution (indicated by the yellow area), the observed window is considered to be significant.

Summary

- Young adults were faster in the formation of attention set and target selection under more definitive task instructions (instructional cueing), while older adults might have chosen to focus attention more unilaterally and efficiently under less definitive task instructions (probabilistic cueing).
- The absence of correlation between cue-related decoding accuracy and attentional modulation of target-evoked N1 in older adults suggests an age-related deficits in attention control.
- The preserved correlation between target-related decoding accuracy and behavior in older adults suggests that attention selection during target processing is relatively resistant to normal aging.