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Dissociable mechanisms underlying individual differences in Working Memory Capacity

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QUESTION

The ability to control attention to minimize distraction is the primary factor determining working memory capacity (WMC)^{1,2}, a characteristic that strongly correlates with cognitive abilities, including intelligence³. We tested whether superior attention control abilities exhibited by high-WMC individuals are mediated by

- stronger suppression of irrelevant information,
- enhancement of relevant information,
- or both?

TASK

RESULTS

Behavioral performance

Attentional modulation of SSVEPs

Strategic WMC-related differences in both target and distractor processing

- Both WMC groups: increased attention to the target compared to the flankers;
- Different strategies to obtain the same signal-to-noise ratio: The low-WMC increased attention to the target, whereas high-WMC suppressed attention to the flankers.

Control analysis

Statistically significant group differences in SSVEP amplitudes were observed only in occipital electrodes that showed strong SSVEPs.

Conflict-related theta-band (3-7 Hz) power

- Increase in theta-band (3-7 Hz) power in peri-response time interval (-200 - 100 ms) in frontocentral electrodes
- Main effect of congruency ($F(1,31) = 8.96, p = .005$)

No WMC-related differences in midline theta power: no main effect of WMC, no WMC x congruency ($F(1,31) < 1$)

Significantly earlier recruitment of cognitive control networks in high-WMC group on incongruent trials: Group x Congruency interaction ($F(1,31) = 3.94, p = .056$) Incongruent trials ($t(31) = 2.13, p = .041$)

Single-trial analyses

Linear mixed effects model with:

- Dependent variable: reaction time;
- Fixed effects: congruency, WMC group, flicker frequency, theta-band (3-7 Hz) power in peri-response time window (-200 - 100 ms), target and flanker SSVEP amplitude in stimulus-response window;
- Random intercept per subject.

DISCUSSION

- WMC is related to the control of attention to both relevant and irrelevant information. High-WMC individuals inhibit distractors more strongly, whereas low-WMC individuals enhance targets. Two different strategies can result in similar behavioral performance, yet suppression might be more neurally efficient⁴.

- In a frequency-tagged version of the Eriksen flanker task, as in a standard version^{5,6}, conflict-related theta power was increased. However, frontal midline theta did not show WMC-related differences.

- General implications for the use of SSVEPs to study cognitive processes. SSVEPs can be successfully applied to cognitive tasks with small stimuli and relatively short stimulus presentation times.

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