Eye fixation-related potentials in change detection

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Change detection involves encoding of target objects into memory, retention of the memory representation, retrieval of the representation, and comparison of that representation to the changed image (Hollingworth & Henderson, 2002; Zelinsky, 2001). Change blindness may, in principle, arise from failure in any of these processes (Hollingworth, 2003). Our present study is focused on encoding failures.

We propose that the encoding failures arises in free viewing as a result of the *deviation between eye movements and attention* during visual selection.

Change blindness paradigm (stimuli from Rensink et al., 1997)

Time course of a trial

1. Encoding 20 s
2. Search of the change until response
3. Feedback

Participants in the change blindness paradigm (Rensink, O'Regan, & Clark, 1997) memorized photographs of natural scenes during 20 s and, after a short-term mask, were asked to detect the change.

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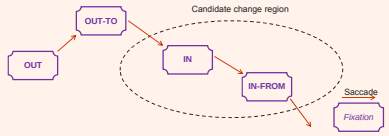
Four fixation locations around a candidate region of change



We studied eye movements and EEG at the encoding stage: 20 s presentation of the first display

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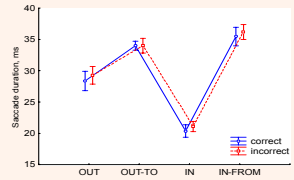
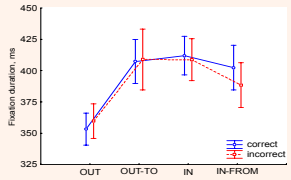
Eye movement results

Saccade duration (size)



Fixation duration



Encoding-stage saccade and fixation durations reflect the size and importance of the regions, but not correctness of selection

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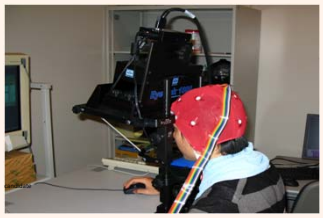
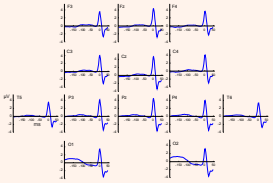
Simultaneous eye movements and EEG recording

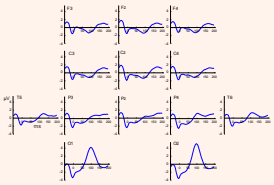


Eye fixation-related potentials (EFRP)

EFRP time-locked to the saccade onset



EFRP time-locked to the fixation onset



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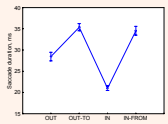
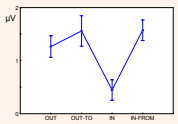
Control with pseudo-change regions

The positions of change regions were shuffled between all 48 picture. EFRPs were computed relatively these pseudo change regions in order to determine where and how the EFRP is explained by saccade sizes only.

Saccade duration (size)



EFRP amplitude in -20+20 ms interval before a saccade



In the control analysis there is no difference between correct and incorrect selection. The EFRP reflects the saccade sizes only in -20+20 ms interval before a saccade.

Acknowledgements

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Eye fixation-related potentials (EFRP) time-locked to saccade onset

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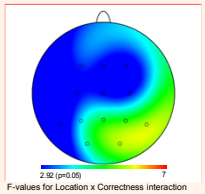
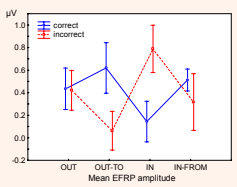
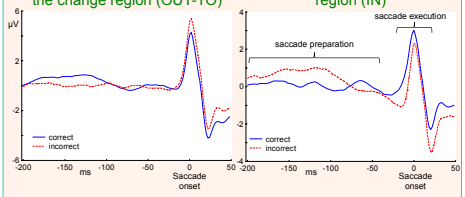
-200-20 ms before a saccade (saccade preparation)





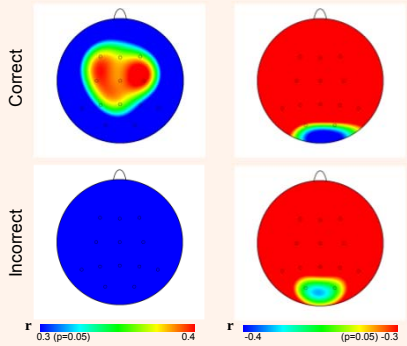
Fixation preceding a saccade to the change region (OUT-TO)

Fixation inside the change region (IN)



Correlations of EFRP with eye movements

Saccade duration | Fixation duration



Deviation between eye movements and attention results in encoding failures.

Conclusions

- Correct and incorrect selection of a candidate change region is accompanied by the same pattern of eye movements (Panel 3). They differ, however, during saccade preparation (-200-20 ms before a saccade) (Panel 6). Here, brain activity corresponding to saccade size leads to correct selection, no correspondence leads to incorrect selection.
- Incorrect selection, therefore, resulted from *deviation between attention and eye movement* preparation. When deployment of attention does not coincide in direction with the saccade, it may lead to inability to select and, subsequently, encode the target region.