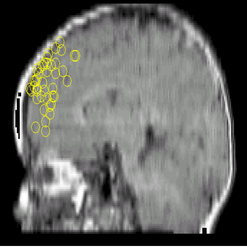
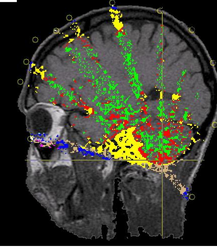


Infant Sustained Attention Affects Brain Areas Controlling Covert Orienting

John E. Richards
http://jerlab.psych.sc.edu/pdf/srcd63-2007.pdf
UNIVERSITY OF SOUTH CAROLINA



Background

Infants covertly move attention around in space without moving fixation. This is shown in the "spatial cueing" procedure in which a cue indicates the side of an upcoming target or is contralateral to the target ("valid" and "invalid"). Brain activity in this task may be measured by ERPs occuring in response to cued or uncued targets. The current study used heart-rate-defined attention phases to examine ERP spatial cueing effects under conditions of attention and inattention.

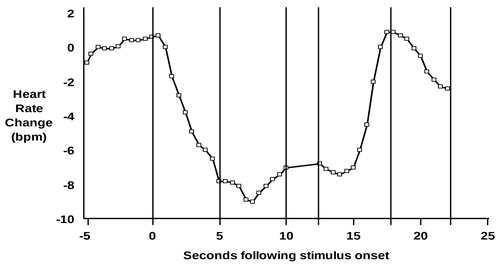
Methods

Participants: Infants at either 14- or 20-weeks of age were tested.

Stimuli and Procedure:

An interesting visual stimulus was presented on a large monitor. A small cue was placed in the periphery for 150 ms, then no stimulus in the periphery and no central stimulus, followed by a target in the same location as the cue (valid trial) or opposite location (invalid trial). Some trials had the cue only (cued-control) and some had the target only (neutral). The SOA between cue and target was 350 or 1350 ms. The EOG was used to monitor the onset of the eye movements toward the target location. Reaction time was measured as the first eye movement toward the peripheral location.

Heart Rate Phases Heart rate changes were used to assess "attentive" and "inattentive" fixation at the time of target onset. "Stimulus Orienting" and "Sustained Attention" occurring during looking toward the stimulus was defined as attentive. "Attention Termination", and periods of time after attention termination before another stimulus orienting, were defined as inattentive.

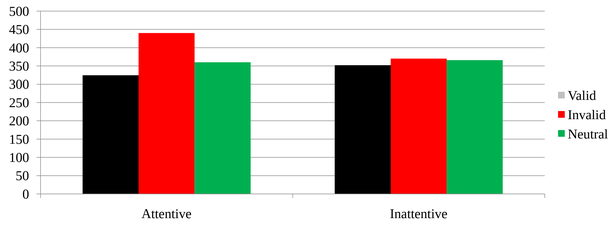


Reaction Time

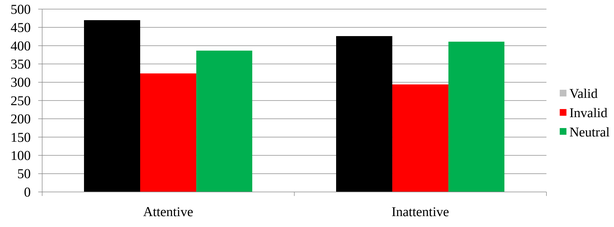
The reaction times were analyzed as the difference between the target onset and the first eye movement toward the target. Eye movements toward the target could occur on the valid, invalid, or neutral trials. We also recorded eye movements toward the cued side but without the cue being present (before target; cued-control; toward ipsilateral side on the contralateral trials). The table below shows that the majority of trials on the cued-control were accompanied by an eye movement toward the cued side; and there were a significant number of eye movements toward the cued side before the target appeared, and toward the cued side when the target was on the contralateral side.

Trial Type	Toward Target	Endogenous
Valid	267 (60%)	183 (40%)
Invalid	402 (62%)	245 (38%)
Cued control	133 (35%) * (away from cue)	247 (65%)

The reaction times on the short SOA trials are presented in the figure below. There was a facilitation of RT for the valid trials, a cost for the ipsilateral cue on the invalid trials, compared to the neutral trials. This effect occurred primarily when the infant was attentive.

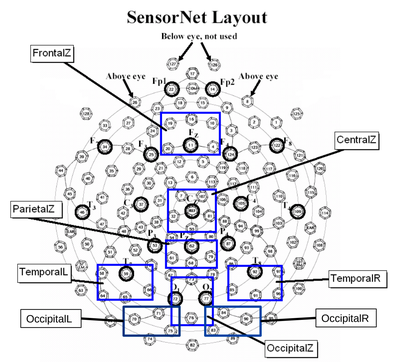


The reaction times on the long SOA trials are presented in the figure below. There was an inhibition of return on the valid trials when the infant was attention, and a facilitation of RT on the invalid trials irrespective of attention state.



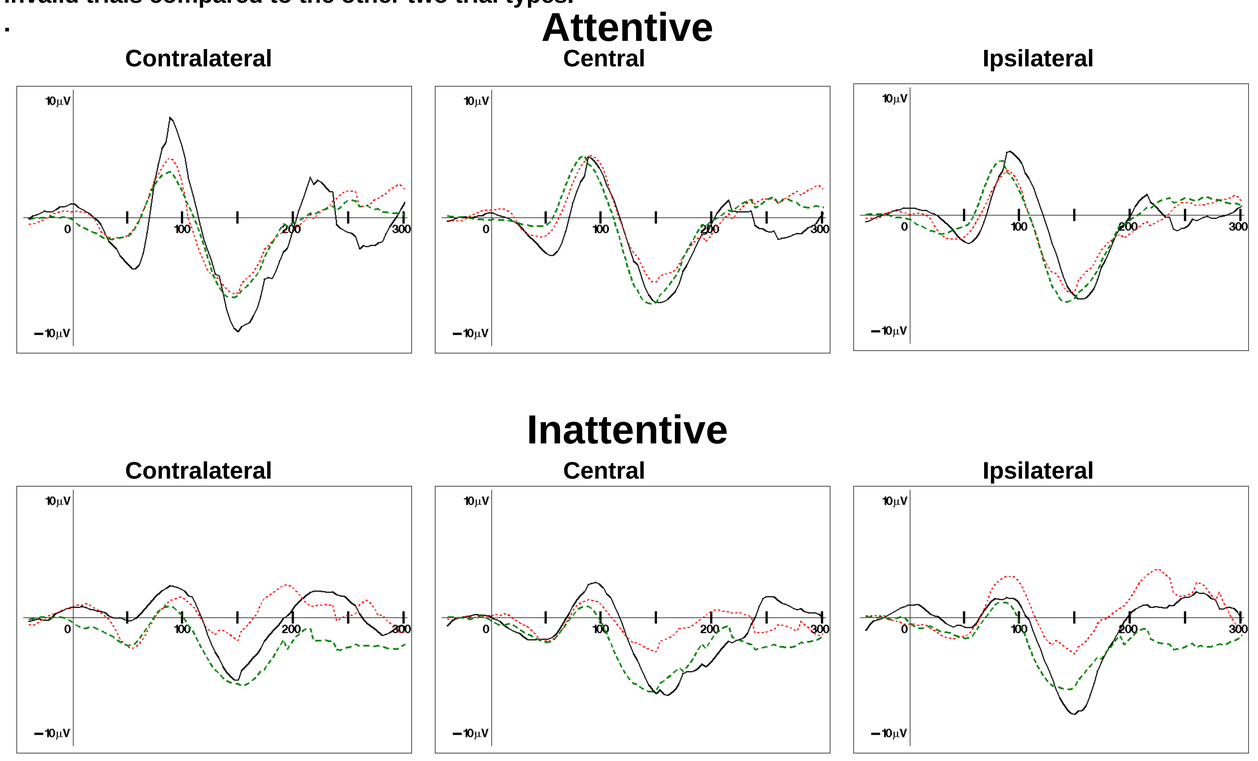
Event Related Potentials

EEG/ERP Analysis A high-density 128 channel EEG recording system was used. The ERP was calculated from 50 ms before the onset of the target until 50 ms before an eye movement was made toward the target. The data were averaged over several electrodes, corresponding to the lateral occipital areas (contralateral and ipsilateral to target), lateral temporal areas (contral lateral and ipsilateral to target), and central occipital area



The ERP results are show below. There was a P1 validity effect for the ERP on the contralateral occipital electrodes during attention. The validity effect did not occur at central or ipsilateral sites. The P1 validity effect was much larger on the short SOA trials than on the long SOA trials. On all electrodes, the ERPs were larger during attention than during inattention. An unexplained effect was an attenuated N1-type component on the invalid trials compared to the other two trial types.

.



Conclusions

Traditional ERP analyses showed a "validity effect" in which there was an enhanced P1 on valid trials over invalid and neutral trials. This occurred on the contralateral occipital and temporal electrodes, and occurred during attentive periods. The effect occurred primarily on the short SOA trials. This implies that this is due to short-latency enhancement of the secondary visual areas from bottom-up processes (short-SOA effect) rather than modulation by top-down process (lack of long-SOA effect). Attention affected the overall amplitude of the ERPs suggesting that the attention effect was not necessarily specific to the selective attention processes but acted as an arousal effect. However, the response processes were affected by attentiveness, as shown by both the inhibition of return and facilitation of contralateral responses on the long-SOA trials. This suggests that the early processing of the target, reflected in the ERP, is largely affected by bottom-up processes whereas later response processing also is affected by top-down processes. Preliminary cortical source analyses showed that the P1 ERP effects occurred in the extriastriate occipital cortex and fusiform gyrus. The effect of attention on these areas was to enhance the activity in the brain area rather than affecting spatial configuration of the cortical source.