The Relation between Infant Covert Orienting, Sustained Attention and Brain Activity

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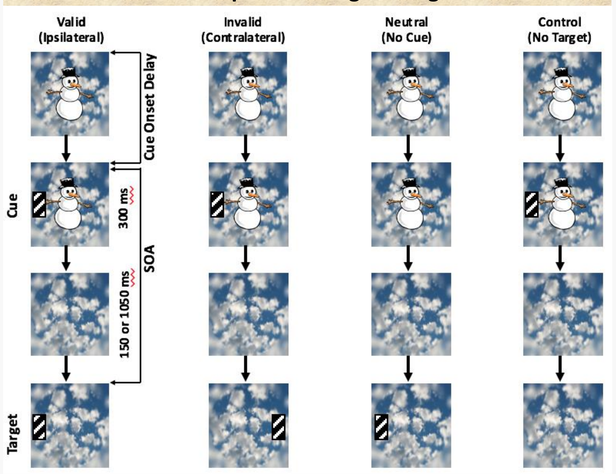
Abstract

- **The current study investigated the cortical activity involved in infant covert orienting, and how it would be affected by the stimulus onset asynchrony (SOA) duration.**
  - We measured infant ERPs and applied cortical source analysis to measure the current density amplitudes in brain ROIs that are likely involved in covert orienting [1,2].
  - We used the spatial cueing paradigm and tested separate groups of infants in the short and long SOA conditions to increase the number of trials and presumably enhance the power for finding a significant difference between short and long SOA conditions.
- **The current study also aimed to determine the effect of sustained attention on infant brain activity involved in covert orienting.**
  - We used ECG recording to define infant sustained attention and inattention periods[3,4]. The ECG recording was synchronized with EEG recording.
- We found the effect of cue-target validity on infant ERP responses differs with the SOA conditions.
  - E.g., The P1 validity effect was only shown in the short SOA condition, which is consistent with behavioral and adult ERPs research[2,5,6,7].
- Cortical source analysis showed that the (contralateral) inferior occipital and ventral temporal regions activated differently between the valid, invalid, and neutral conditions.
- Infant sustained attention was found to modulate infants' brain responses in covert orienting by enhancing the P1 and N1 ERP responses and current density amplitude in their cortical sources during sustained attention.
- **Conclusion:** the neural mechanisms that underpin covert orienting already exist in 3- to 4.5-month-olds, and they could be facilitated by infant sustained attention.

Methods

- *Participants*
  - 3 months (N=21)
  - 4.5 months (N=21)
- *SOA types*
  - Short SOA: 450 ms (used in half of the participants)
  - Long SOA: 1350 ms (see the paradigm below)
- *ECG & EEG acquisition and analysis*
  - Trials were categorized into sustained attention and inattention conditions based on HR changes
  - EGI High-density 128 channel net
  - EEGLAB, ERPLAB, Matlab for data processing
- *Cortical source analysis*
  - Realistic infant MRIs from the Neurodevelopment MRI Database[8]
  - Fieldtrip toolbox and in-house custom MATLAB scripts.

Infant Spatial Cueing Paradigm

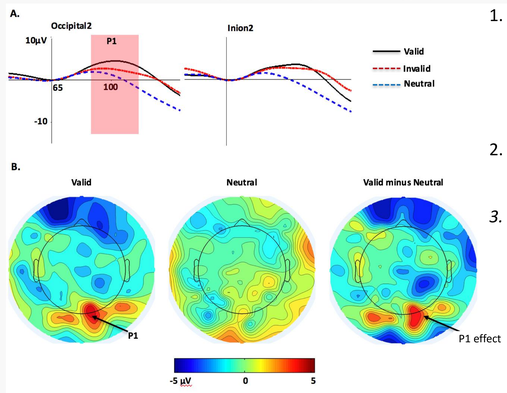


Results

Download at: http://jerlab.psych.sc.edu/jerpdf/ICIS2016spatialcueing.pdf

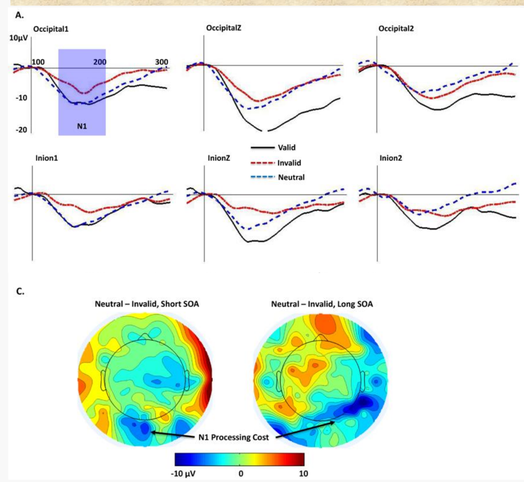
ERPs Results

FIGURE 1 | P1 validity effect in the short SOA condition



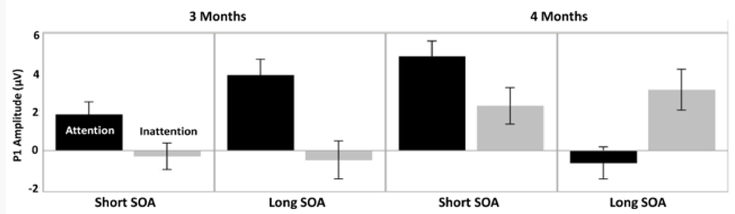
1. The P1 validity effect (valid > neutral) was found in the contralateral posterior (O2, I2) electrodes only for the short SOA condition.
2. No effect for the long SOA condition.
3. *Note*: We flipped the channel locations (left to right, right to left) for targets presented in the right visual field, i.e., channels in the right hemisphere are always contralateral to the targets.

FIGURE 2 | N1 validity effect (short SOA) and processing cost effect (both SOA conds)



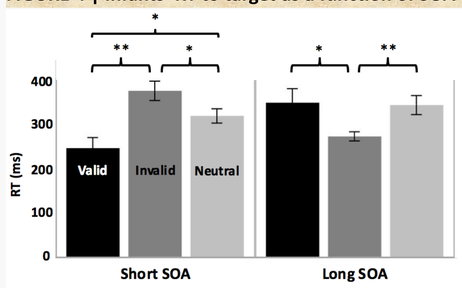
1. The N1 validity effect: valid > neutral and invalid in both ipsilateral and contralateral posterior electrodes for the short SOA condition.
2. The processing cost effect: neutral N1 amplitude > invalid N1 amplitude in both short (O1, I1, Iz) and long (O2) SOA conditions.

FIGURE 3 | Sustained attention effect on P1 responses for two ages



Behavioral Results

FIGURE 4 | Infants' RT to target as a function of SOA condition and cue-target validity



1. The validity effect was found in the short SOA condition.
2. The IOR effect is not consistently shown in the long SOA condition: Valid > Invalid, but Valid = Neutral.
3. No interaction with age was found.

Cortical Source Analyses Results

FIGURE 5 | Source activity for the validity (left) and processing cost (right) effects shown in an infant MRI

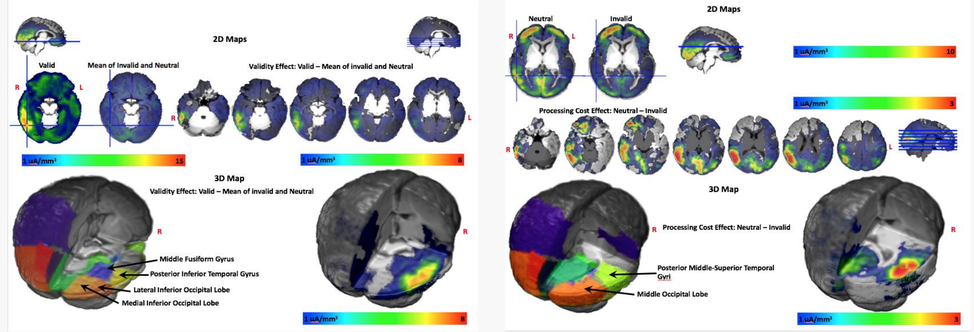


FIGURE 6 | CDR value surrounding the P1 component in the ROIs that showed significant validity effect

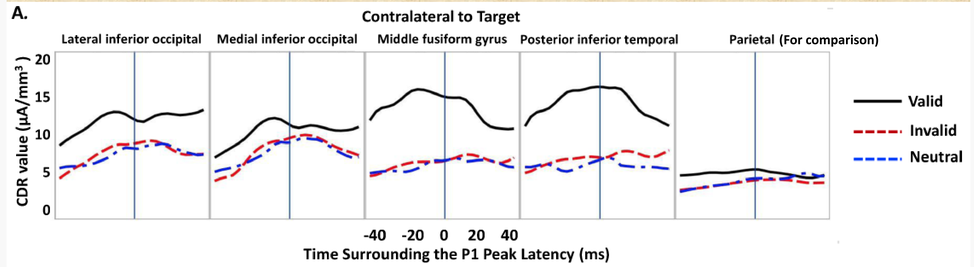


FIGURE 7 | CDR value surrounding the N1 component in the ROIs that showed significant processing cost effect

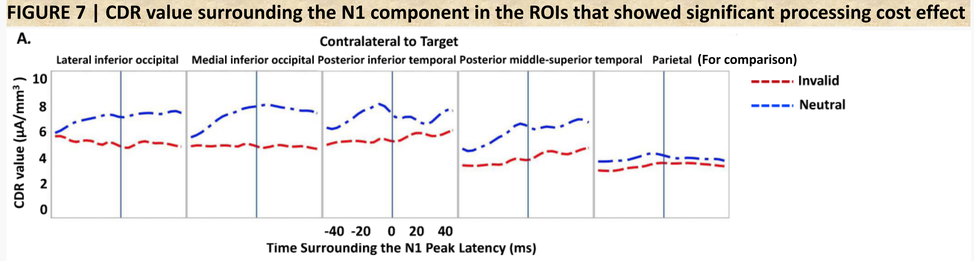
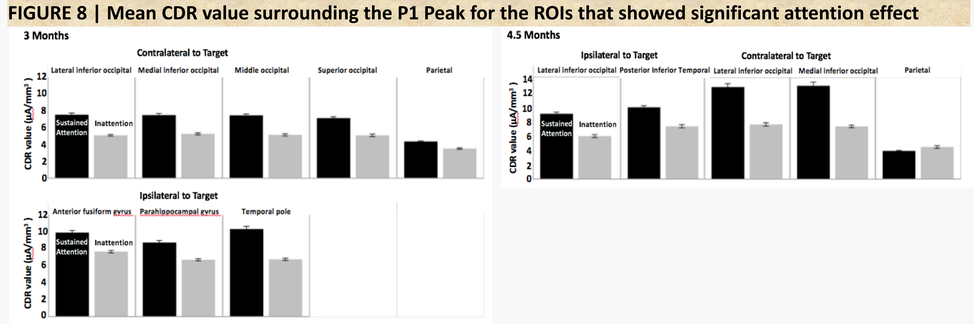


FIGURE 8 | Mean CDR value surrounding the P1 Peak for the ROIs that showed significant attention effect



Acknowledgement: This work was supported by NICHD R37-18942 to John E. Richards.

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