Developmental Changes in the Infant N290 in Response to Faces and Toys

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INTRODUCTION

Specialized processing of faces begins early in life, yet we are just beginning to understand the neural underpinnings of the development of face expertise in infancy. Adults exhibit differential neural responses to faces as opposed to other classes of objects, evidenced by a larger N170 amplitude for faces than for objects. The N170 is a negative event-related potential (ERP) component occurring about 170ms post-stimulus onset, and research with infants has found two components that may be precursors to the adult N170. One of these components, the N290, is a negative deflection over posterior regions peaking at 290ms that is greater in amplitude for faces than visual noise[1]. In the first year of life, as infants acquire extensive exposure to faces, the N290 begins to differ in response to upright (as opposed to inverted) faces and to human (as opposed to monkey) faces[2]. However, few studies have examined whether changes occur in the morphology of the N290 that correspond to emerging expertise with faces as opposed to other objects. In the current study, infants' ERPs were recorded while infants of three different ages (4.5, 6, and 8 months) passively viewed faces and objects (toys). Additionally, cortical source localization was performed on the N290 component to examine any difference in source activation across conditions or age groups.

METHOD

Pictures were taken of the infant's mother and infant's favorite toy when they arrived for the study.

Participants:
14 4.5-month-olds, 17 6-month-olds, 13 8-month-olds

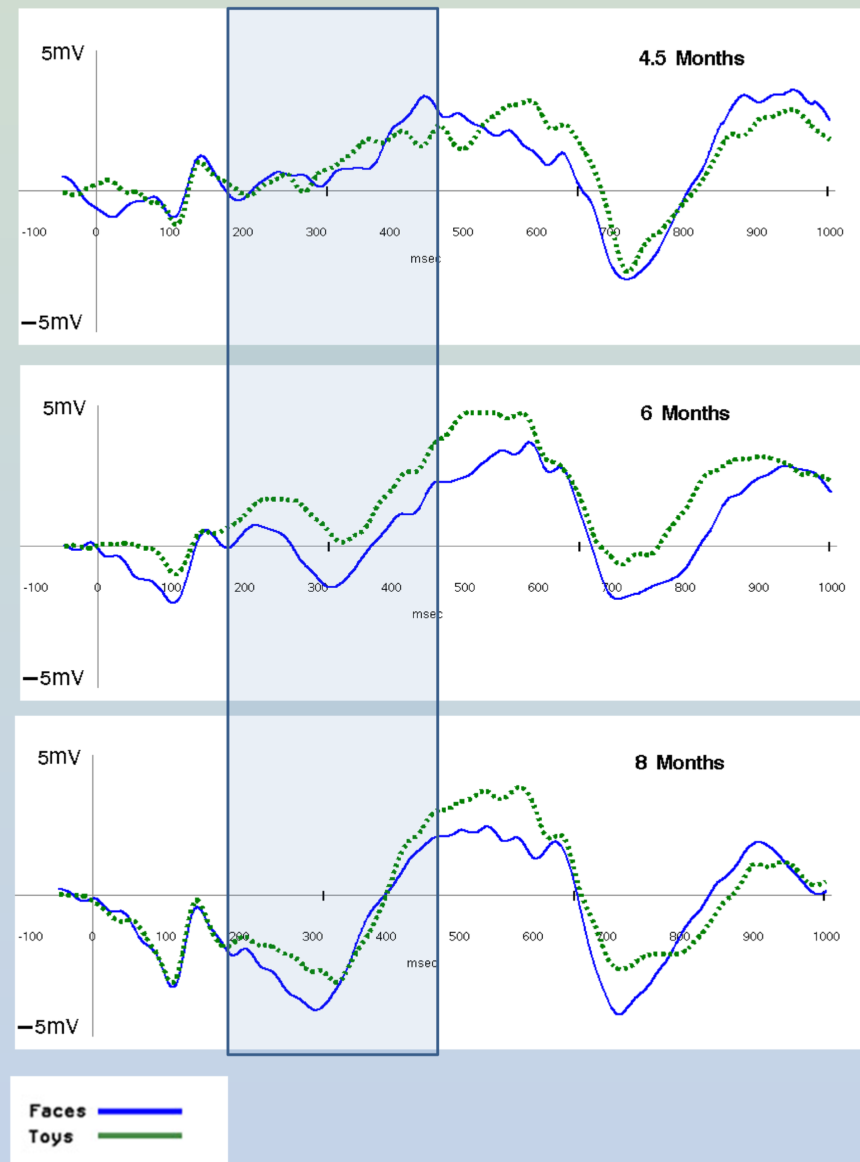
Stimuli: Images of: infant's own mother, another infant's mother, infant's own toy, another infant's toy

Procedure:

- Infants passively viewed a series of brief stimulus presentations (500 ms) of the images randomly interspersed across trials.
- High-density EEGs were recorded using an EGI 128-channel Geodesic Sensor Net.
- EEG data was analyzed for groups of electrodes over occipito-temporal regions (e.g., around T5, T6, O1, O2, Oz) based upon previous infant studies (de Haan et al., 2002).
- For each participant, ERP grand averages were computed for the time of the target onset, and the peak amplitude was derived using individualized time windows to capture each subject's N290.

RESULTS

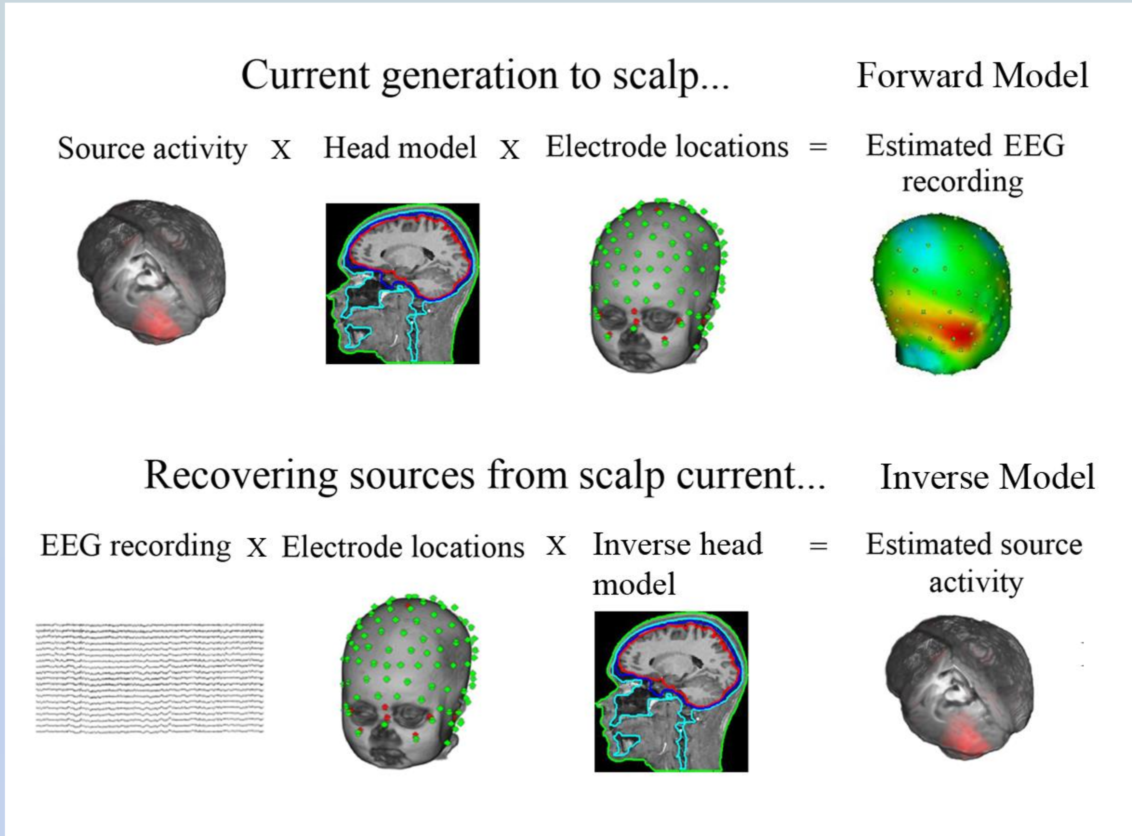
The dependent measure was the mean amplitude of the N290 component. A main effect of age was found [$F(2, 88)= 5.81$; $p < .005$*], and the increase in the amplitude of the N290 from 4.5 to 7.5 months can be clearly seen in the Figure below. There was also a marginally significant effect of trial type [$F(1,88)=3.26$; $p < .07$], as the amplitude was larger for faces than for toys (but the interaction was not significant). Thus, the N290 amplitude was larger for faces than for toys (see Fig. 1), and increased in amplitude across the age groups.



N290 peaks (see highlighted areas) for 4.5-, 6-, and 8-month-olds while viewing faces or toys.

SOURCE LOCALIZATION OF THE N290

Previous research with adults has found areas in the brain (such as regions of the fusiform gyrus) that are more active when viewing faces than other objects[3]. In studies with both children and adults, neuroimaging techniques such as positron emission tomography (PET) and fMRI are routinely used to identify these face-sensitive areas. However, these techniques are impractical for routine use with populations such as young infants. An alternative approach is to use EEG recordings and cortical source localization techniques, which are appropriate for use even in young infants.

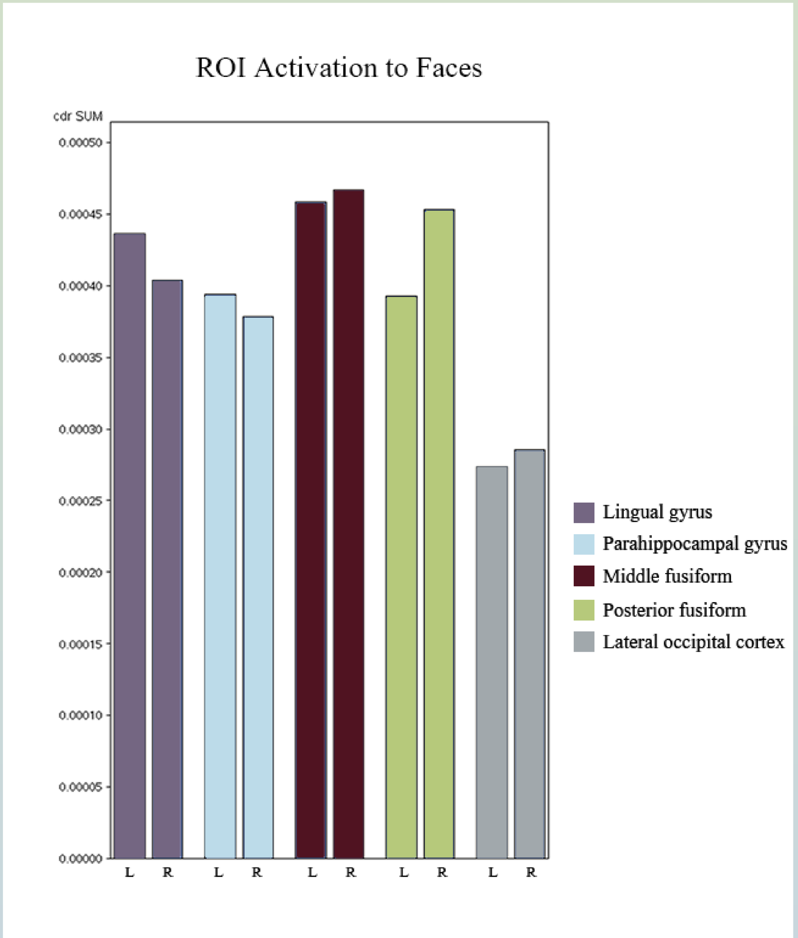


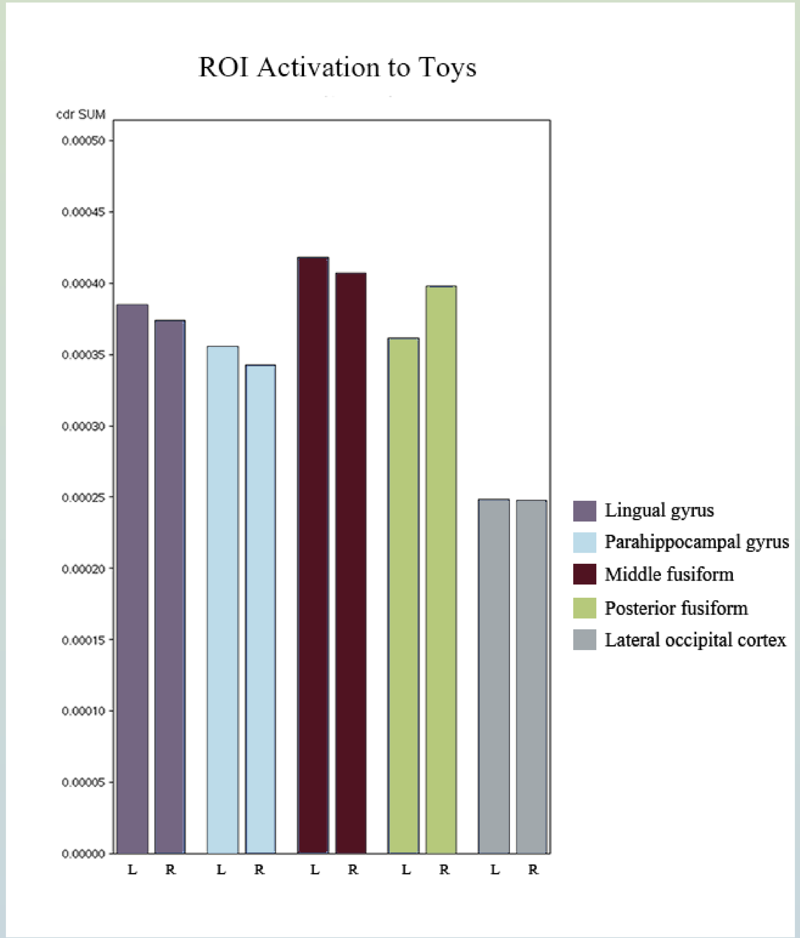
SOURCE LOCALIZATION METHOD

EEG signals measured on the scalp surface do not directly indicate the location of the active neurons in the brain. Localization of scalp ERPs is achieved by solving the "inverse problem"; i.e. recovering source locations from current measured at the scalp (see Figure above-right). We used the sLORETA method to perform current density reconstruction of the neural generators of the N290 component. To quantify cortical sources of activity from EEG recordings, a head model is used that specifies the spatial distribution of the materials in the head and takes into account their relative conductivities. Models with realistic descriptions of the head's interior perform more accurately than the more basic spherical models of head compartments (e.g., skin, skull, brain)[4]. Thus, the infants' own structural MRIs (or in some cases, age-appropriate infant templates) were used to create realistic head models using a finite elements model (FEM).

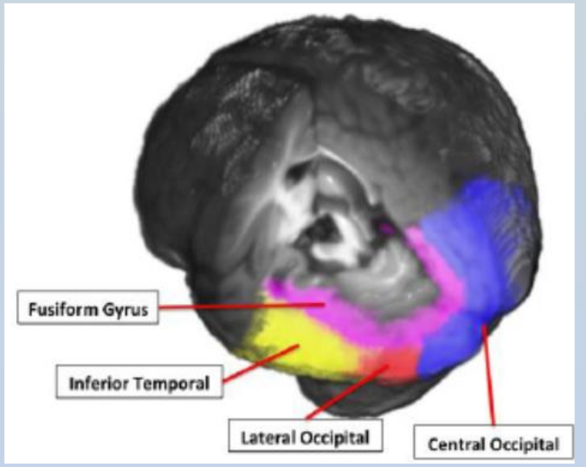
SOURCE LOCALIZATION RESULTS

Activation (given in Amps-meter) for the left and right hemispheres of select ROIs at the peak of the N290.





Regions of interest (ROIs) were chosen based upon previous research[5–6] and CDR activation was analyzed for the peak of the N290. Greatest activation was found in the middle fusiform gyrus, with the posterior fusiform gyrus, parahippocampal gyrus and lingual gyrus also showing significant activation at the latency of the peak N290. These areas were active when viewing both faces and toys, but showed greater activation to faces. There was also a distinct hemispheric asymmetry in the posterior fusiform gyrus; the right hemisphere showed greater activation than the left, particularly when viewing faces. This is consistent with previous adult research that has found a right hemisphere advantage that is associated with specialized processing of faces[7].



A cut-away image of an adult brain with some of the areas associated with face processing highlighted.

POSTERIOR FFG RESULTS

An age-group (4.5, 6, 8 months) x stimulus type (faces, toys) x hemisphere (left, right) ANOVA found no significant interactions, but the following main effects:

- There was a significant main effect of age, $p<.04$.
- There was a significant main effect of hemisphere , $p < .04$.
- There was a marginally significant effect of stimulus type $< .09$.

CONCLUSIONS

The current study documents a developmental change in the face-sensitive N290 corresponding to a time period when infants are developing expertise with faces. These studies suggest that, like adults, infants demonstrate special processing of faces compared to other objects, and that the N290 is similar to the N170 in that its amplitude is greater to faces than other objects. Additionally, the source analysis of the N290 implicates areas associated with face processing in adults as the neural generators of the infant N290. The greater activation in the right posterior fusiform while viewing faces further suggests that neural specialization for faces is developing early in life.

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