Infant's Brain Response to Mother's Voice – Relationship to Socioemotional Development

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Introduction

- Infants are able to discriminate between emotional prosody and identify their mother's voice, however there have not been sufficient studies of **infant processing of maternal emotional prosody**.
- It is unclear what neural activation to social and emotional stimuli means for infant's **development and behavior.**
- The current study examines the degree to **which infant's socioemotional development interacts with the processing of emotional prosody and mother's voice**
- We hypothesize that infants with a higher socioemotional development score will **be more sensitive to maternal positive affect**, as compared to a control woman's voice, with **increased activation in regions responsible for social and emotional processing**

Methods

Participants: N=22; 16 with useable data

Task:

- In the MRI scanner, **sleeping infants** listened to stimuli through headphones. **Mother's voice** and a control woman's reading nonsense sentences in four emotional tones **– neutral, happy, sad, and angry** were played for 20 second blocks. Each 20s block was separated by an average 10 second rest period (ranging from 8 to 12 seconds), during which no sounds were played over the headphones. The block order was randomized and each condition (actor: mother and control, emotion: neutral, happy, sad, angry) was repeated 5 times for a total scan time of around 20 minutes.

Measures:

- **Infant's Socioemotional Development Score** is an index of their social and emotional competency relative to age-normed developmental milestones. It was collected using the Bayley-III Scales of Infant and Toddler Development. Maternal report of **infant's social and emotional skills** usage is collected and scaled.

Table 1. Demographic Characteristics

	Minimum	Maximum	Mean	Std. Deviation
Infant Age	11.37	24.15	15.8036	4.12095
Gestational Age (Weeks)	37.00	41.71	39.6667	1.55245
Infant Sex	Percent Male	62.5%		
Infant Race	Percent White	37.5%	Percent African-American	12.5%
Family Income-to-Needs Ratio	.19	5.76	2.9219	1.78826
Infant Social/Emotional Development Bayley Score	7	19	12.38	3.384

fMRI Parameters

Acquisition and Processing

Scanning took place in a 3.0 Tesla Siemens magnet scanner using a standard 32-channel head coil. Functional data were acquired (531 T2*-weighted echo-planar-imaging (EPI) volumes; TR = 2,300 ms; TE = 27 ms; flip angle = 73; field of view = 192 mm; matrix size, 64 × 64; 36 axial slices; voxels = 3mm^3). Images were preprocessed and analyzed using **Analysis of Functional Neuroimages** software (AFNI). Images with motion greater than **0.5 mm** in any direction were censored and participants with more than 70% useable images were retained for analysis. Images were spatially smoothed with a 6-mm root-mean-square deviation Gaussian blur. Brain images were registered into a UNC infant 0-1-2 atlas (Feng et al, 2011)

Analysis

AFNI's 3dLME:

Infant's socioemotional development score * Emotion(neutral, happy, sad, angry) * Actor (own mother, control woman) + infant age

k ≥ 134 with a height threshold of **p < 0.005**, equivalent to a whole brain corrected false positive probability of p < 0.05, as calculated by 3dClustSim using the spatial autocorrelation function (**-acf**) option.

Figure 1. Emotion x Actor x Bayley Activation Map

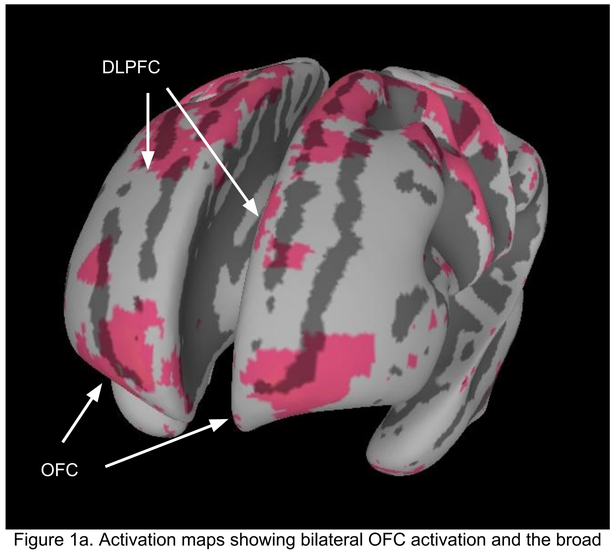


Figure 1a. Activation maps showing bilateral OFC activation and the broad occipito-parietal-frontal activation

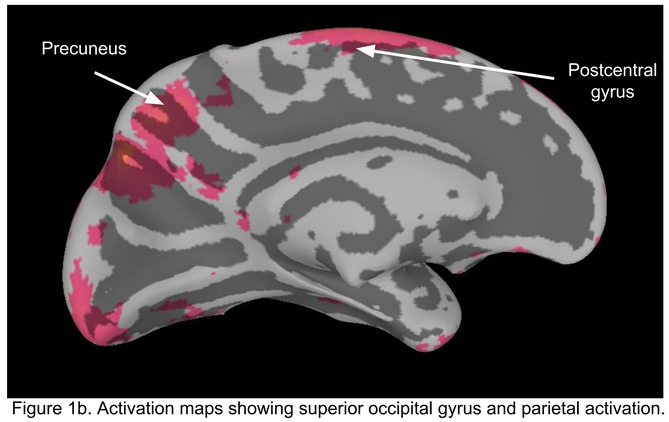
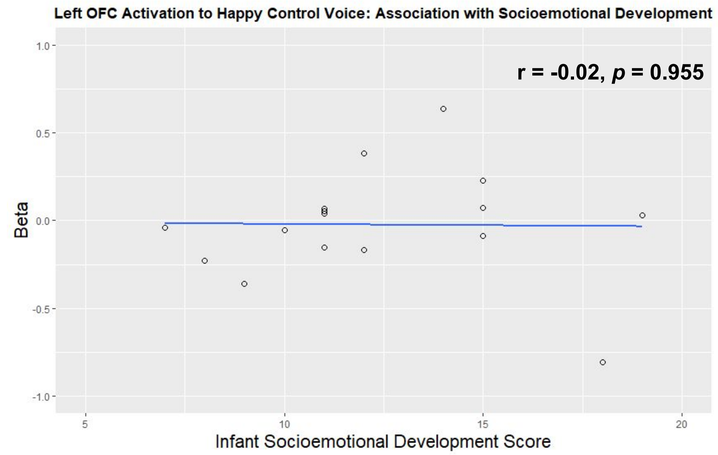


Figure 1b. Activation maps showing superior occipital gyrus and parietal activation. Left hemisphere view

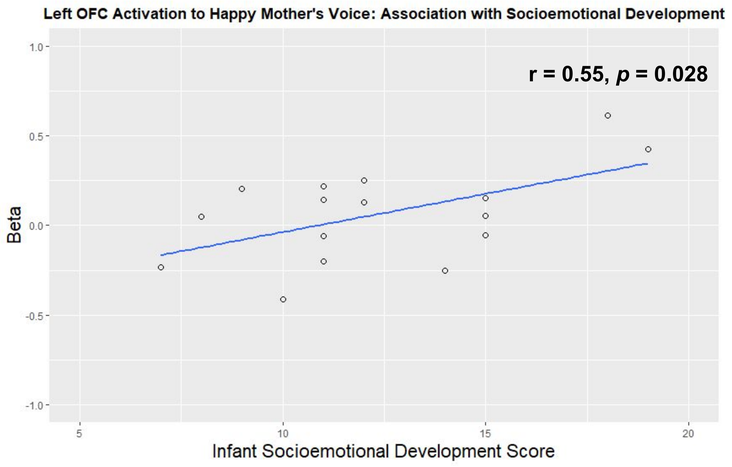
Table 2. Brain Areas with Significant Interaction

Regions	BA	Side	x	y	z	Cluster size
Superior Occipital Gyrus (Precuneus, Pre/PostCentral Gyrus, Bilateral IFG, Bilateral DLPFC)	19	L	-16	-67	32	3719
Cerebellum	n/a	R	14	-40	-52	396
Cerebellum	n/a	L	-19	-31	-52	351
OFC	10	R	20	50	-7	285
OFC	10	L	-13	56	-1	191
Inferior Temporal Gyrus (Fusiform Gyrus, Temporal Pole)	20/37	R	20	2	-43	148

OFC and Happy Control Voice



OFC and Happy Mother's Voice



Discussion

- Infants with higher socioemotional development showed **increased activation to mother's voice.**
- This effect was found in several clusters, **including the OFC and ITG that have been implicated in social and emotional processing**. Additionally, a large cortical cluster peaking occipitally and extending fronto-parietally was also activated with a similar pattern.
- This research demonstrates that **infants show a neural preference towards mother's voice** and respond differently to different emotional prosody across a variety of brain areas. Additionally, this research shows that increased **socioemotional development is associated** with increased activation to mother's voice (particularly happy voice) in areas of the brain responsible for social and emotion information processing in adults.
- More research is necessary to understand the **directionality** of the association between neural sensitivity to mother's voice and socioemotional development in infancy.

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