# Supplementary Materials

## Methods

### Participants

Scans were attempted for 39 infants with 24 completing the scanning protocol. For each infant, up to two visits to the Lewis Center were made to attempt scanning. Fifteen infants did not complete the scanning protocol due to difficulty falling asleep at the scan center or waking during the protocol. For the 24 infants scanned successfully, race and ethnicity were representative of the community in which recruitment occurred (83.3% Caucasian and 16.67% other or more than one race; 20.8% Hispanic). The median category for gross annual household income was $25,000–$29,999, based on a 12-point scale: 1 (*less than $4,999 per year*) to 12 (*$100,000 or more per year*). With regard to educational attainment for mothers, 8.3% did not complete high-school or a test equivalent, 20.9 % completed high-school or a test equivalent, 37.5% completed some community college, and 33.4% completed at least one year or more of a standard 4-year college. Recruitment through Craigslist and local public sector human services agencies may have skewed the sample towards being of lower socioeconomic-status. Infants scanned successfully did not differ significantly from the rest of the sample with regard to age, gender, race, ethnicity or family income.

### Interparental Conflict Measures

Both measures of interparental conflict, the Psychological Aggression scale of the Conflicts Tactics Scale-Revised (CTS2; Straus, Hamby, Boney-McCoy, & Sugarman, 1996) and the O’Leary-Porter Scale (OPS; Porter & O’Leary, 1980), were adapted in minor ways to focus on infancy and were scored as suggested by the creators of the measures and in a manner consistent with the research literature.

The CTS2 was adapted to ask about partner aggression since childbirth (as opposed to the previous year). Maternal report of aggression toward and received from her partner on the psychological aggression subscale was included in the present study. The response categories on the CTS2 include ranges denoting the frequency with which a behavior occurred**.** The response categories are as follows: 0 (*this has never happened*), 1 (once), 2 (twice), 3 (*3–5 times*), 4 (*6–10 times*), 5 (*11–20 times*), or 6 (*more than 20 times*). Responses indicating a range were recoded to a single number in the middle of the range (i.e., 4 [*3–5 times*], 8 [*6–10 times*], and so on) to represent frequency of aggression as suggested by the author of the measure (Straus et al., 1996). Maternal psychological aggression toward and received from her partner were highly correlated ($r$ = .867 p < .001) and were therefore averaged to create a composite score of psychological aggression in the home (α=.936).

The OPS was adapted for infants to ask about the frequency of arguments in front of the ‘infant’ (instead of the ‘child’). This adaptation simply involved changing the word ‘child’ to ‘infant.’ In addition, one item about physical expressions of hostility was removed from the scale in order to focus on the level of non-physical conflict in the home. The total sum score represents frequency of verbal hostility in the presence of the infant (α=.823).

Maternal report on the CTS2 (Psychological Aggression scale) and the OPS were combined by taking the average of the two in order to capture the overall level of non-physical conflict in the home. Combining the measures was warranted from a theoretical perspective, as both measures focus on non-physical conflict in the home, and from an empirical perspective due to the high correlation between them ($r$ (22) = .744, $p$ < .001).

**Auditory Stimuli**

The emotion category for each sentence was identified by 24 native English speaking adults based on a forced choice of 7 possible emotions including neutral (Pell et al., 2009). The mean percentage of correct category identification for the sentences in each emotion condition in the present study are as follows: very angry (*M*=100%), mildly angry (*M*=97%), happy (*M*=75%) and neutral (*M*=97%). Emotional intensity for each sentence in an emotion category other than neutral was rated on a 5 point scale (with 5 indicating the highest level of emotional intensity) (Pell et al., 2009). Mean emotional intensity for the sentences included in each emotion condition in the present study was as follows: very angry (*M*=4.35, *SD*=.13), mildly angry (*M*=3.30, *SD*=.09) and happy (*M*=3.39, *SD*=.12). Mean and maximum amplitude for the sentences included in each emotion condition are presented below (Table 1).

**Scanning Protocol**

Prior to scanning families came in to the neuroimaging center to fill out questionnaires, as well as learn about MRI safety and scanning procedures with infants. During this session parents completed a screening form regarding potential MRI contraindications for their infant (Lewis Center for NeuroImaging MRI Screening Questionnaire) and signed a release for their infant's physician to fill out the screening form. Parents were given a CD of scan noises to play for three nights prior to the scan session in order to allow infants to become accustomed to the noises. Families came in for scanning at their infants' regular bedtime. Once asleep the infant was placed on the scanner bed. Bilsom pneumatic headphones were then placed on the infant to attenuate noise from the MRI scanner and to present auditory stimuli. Additional soft padding was used between the earphones and the inside wall of the head coil for further sound protection and to stabilize head movements. Two researchers remained in the room throughout scanning to ensure infants' safety and monitor for any signs of wakefulness or distress.

**fMRI Data Acquisition**

Scan parameters for the T2 weighted functional scans were as follows: TR=2000ms, TE=30ms, flip angle=80°, matrix size 64x64, FOV=200mm, 32 slices, 3.125mm in-plane resolution, 4mm thick. A high-resolution T1-weighted MP-RAGE scan lasting 8min was also obtained (TR=2500ms, TE=4.38 ms, TI=1100ms, flip angle=8°, matrix size 256x192, FOV=256mm, 160 slices, 1mm in-plane resolution, 1mm thick).

## Results

**Effects of interparental conflict on processing happy tone of voice**

To examine whether the association between interparental conflict and neural activity during very angry greater than neutral tone of voice is specific to very angry tone of voice we conducted a whole brain regression of interparental conflict on the happy greater than neutral contrast. We found no overlap between the brain areas identified in this analysis and those identified in the regression of interparental conflict on very angry compared to neutral. This suggests that the association between interparental conflict and neural activity in the rostral ACC and subcortical cluster including caudate, thalamus and hypothalamus, is specific to very angry as opposed to happy tone of voice. Although there was no overlap among the regions, interparental conflict was associated with neural activity during happy versus neutral tone of voice in two clusters centered in the right posterior insula extending into the somatosensory cortex and auditory cortex, and in the left posterior insula extending into the somatosensory cortex (see Table 2 and Figure 1). When we covaried for the unique effect of age the cluster on the left extended down to include activation in the left amygdala, extending anterior, superior and lateral to the following peak: Infant xyz= -12, -7 ,-17; MNI xyz= -15, -9, -22; $t$=4.45 (see Table 2 and Figure 1).

Most importantly, we conducted an additional analysis to directly test whether the association between conflict and response to very angry speech relative to neutral was statistically greater than the association between conflict and response to happy relative to neutral speech. The results indicate that interparental conflict demonstrates a greater positive association with neural activity in the rostral ACC (above statistical threshold for multiple comparisons, Infant xyz= 6, 29, 4; MNI xyz= 7, 36, 5; $t$=2.61, k=100) and in the subcortical regions encompassing parts of the hypothalamus (with a cluster size below the statistical threshold for multiple comparisons, Infant xyz= 3, 2, 4; MNI xyz= 4, 2, 5; $t$=2.34, k=17) during presentation of very angry relative to neutral tone of voice than during presentation of happy relative to neutral tone of voice. These results remained consistent when including the age covariate. Taken together these additional analyses indicate that the association between interparental conflict and neural activity during very angry tone of voice relative to neutral is specific to very angry as opposed to happy tone of voice.

## Methodological Issues Relevant to Results

In the present study we did not monitor sleep state during fMRI data collection, which places limitations on our understanding of how variation in sleep state may have affected the results. Research employing simultaneous EEG and fMRI data collection in infants and toddlers to allow for tracking sleep state during functional activation paradigms has not yet been published due to methodological challenges. However, ERP studies with infants provide support for comparable neural processing of auditory stimuli during sleep and wake (Cheour, Ceponiené, et al., 2002), with preservation of response amplitude and latency across different sleep stages (Martynova, Kirjavainen, & Cheour, 2003). Moreover, it appears that learning involving auditory and basic somatosensory stimuli occurs during sleep for infants (Cheour, Martynova, et al., 2002; Fifer et al., 2010; Reeb-Sutherland et al., 2011). With regard to BOLD signal changes during sleep versus wake, research with infants (Dehaene-Lambertz, Dehaene & Hertz-Pannier, 2002) and adults (Czisch et al., 2002; Portas et al., 2000) indicates similar patterns of auditory and linguistic processing in sleep and wake states, with potential dampening of responses during sleep. Thus it seems more likely that the findings would be stronger rather than weaker in an awake state, although future research in this area employing simultaneous EEG and fMRI will be necessary.

**Table 1**

**Amplitude for Each Emotion Condition**

| **Emotion** | **Very Angry** | | **Mildly Angry** | | **Happy** | | **Neutral** | |
|---|---|---|---|---|---|---|---|---|
| | Mean Amp | Max Amp | Mean Amp | Max Amp | Mean Amp | Max Amp | Mean Amp | Max Amp |
| **Mean** | 69.21 | 84.73 | 69.61 | 85.92 | 70.43 | 83.66 | 70.17 | 83.82 |
| **SD** | 1.28 | | 1.36 | | 1.49 | | 0.93 | |

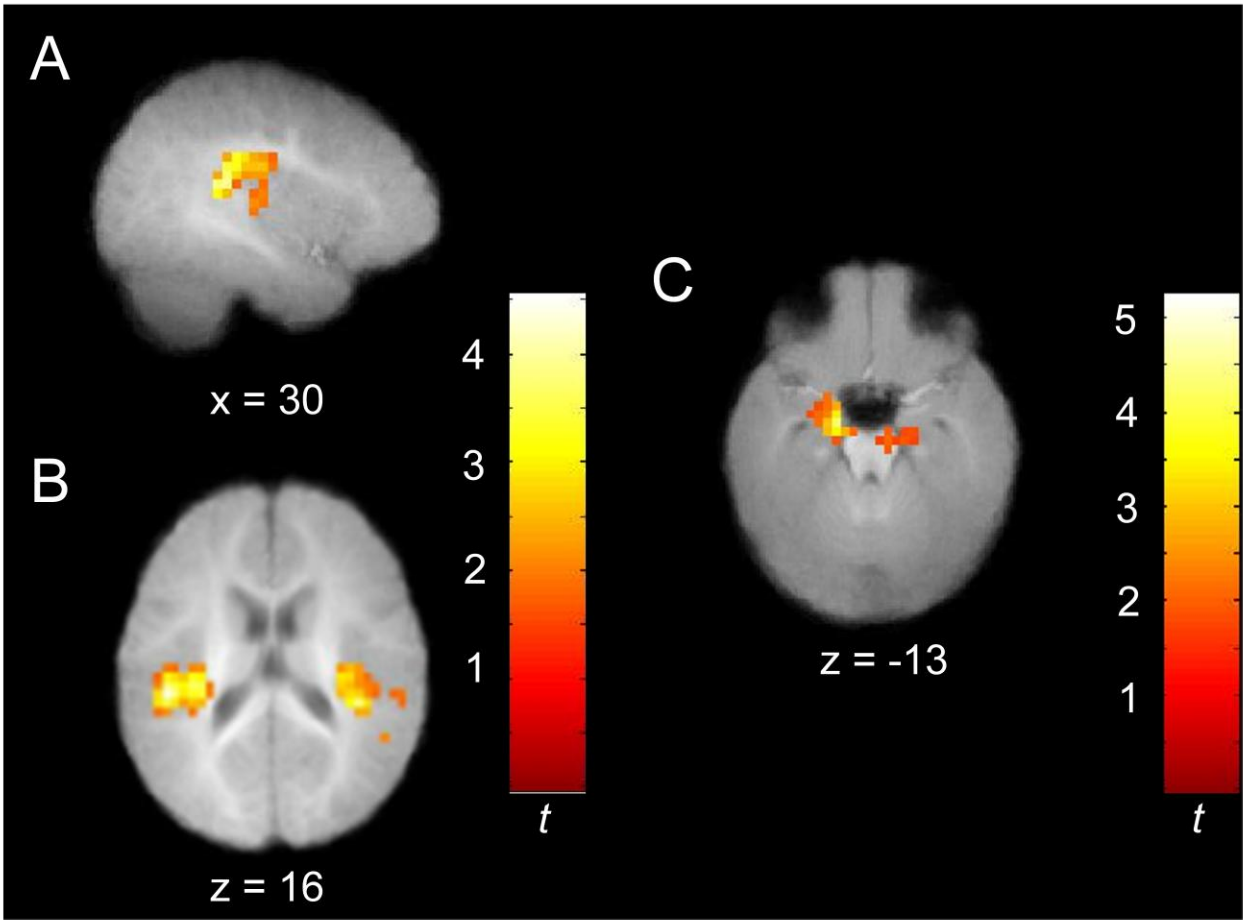
**Table 2**

**Increased activation associated with higher interparental conflict for happy > neutral**

| | | | Infant Atlas | | | MNI Atlas | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Regression** | **Region** | | **x** | **y** | **z** | **x** | **y** | **z** | ***k*** | ***t*** |
| **Positive correlation between conflict and happy > neutral** | Posterior Insula | L | -36 | -22 | 16 | -44 | -27 | 21 | 401 | 4.54 |
| | Somatosensory | L | -36 | -16 | 37 | -44 | -20 | 48 | | 4.49 |
| | Posterior Insula | R | 36 | -34 | 10 | 44 | -42 | 13 | 194 | 4.41 |
| | Somatosensory | R | 30 | -25 | 22 | 37 | -31 | 28 | | 3.82 |
| | Auditory Cortex | R | 42 | -22 | 10 | 51 | -27 | 13 | | 2.63 |

*Note.* Activations FWE corrected (p < .05, 75 voxels). Coordinates without voxel numbers indicate submaxima within preceding cluster. *k* refers to the number of voxels within each cluster. *t* refers to the *t* statistic of the corresponding coordinates (local maxima or submaxima). An additional activation area encompasing part of the left amygdala was evident after adding the age covariate to the regression of conflict on happy>neutral (Infant xyz= -12,-7 ,-17; MNI xyz= -15, -9, -22; *t*=4.45).

**Figure 1**




*Note.* Results are p<.05 FWE corrected. Displayed on group mean structural image. Panels A and B show greater activity in the right somatosensory cortex (panel A) and bilateral posterior insula (Panel B) associated with higher conflict score for the happy > neutral nonsense speech contrast. Panel C shows greater activity in the left amygdala associated with higher conflict score for the happy > neutral nonsense speech contrast when age is included as a covariate.