RESEARCH SUMMARY

Speaker gaze increases information coupling between infant and adult brains. (2017)
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In normal one-to-one face-to-face communication between adults, direct gaze to the eyes of each participant is part of the social signalling that they have each other's attention. It is part of social connectedness. It is well known that adult speaker-listener pairs show synchronisation in the patterns of their brain waves when gaze is part of the conversational process. The brain regions concerned are the inferior pre-frontal gyrus, located at the sides of the forehead, which is involved in language processing, and the pre-frontal and parietal cortices which are linked respectively to the maintenance of attention and to the integration of different forms of sensory information. The question addressed in this paper is whether this neural synchronisation develops in early infancy.

The experiment was designed in two parts:

Experiment 1: The infants watched a pre-recorded video of an adult female experimenter singing nursery rhymes. The neural activity of the infant was recorded live, whilst the adult's activity was pre-recorded.

Experiment 2. A different group of infants watched a live adult female experimenter reciting nursery rhymes. Both the infant and the adult had their neural activity recorded simultaneously.

In both experiments, the gaze direction was manipulated in three different ways by the same adult female experimenter: 'direct face-to-face' eye contact with the infant; 'indirect oblique' (head turned 20 degrees with eyes not looking at the infant's eyes), and 'direct oblique' (head turned 20 degrees with eyes turned to look at the infant's eyes). There were 19 infants in experiment 1 with a mean age of 8.2 months. Experiment 2 had 29 infants with a mean age of 8.3 months. The infant's mothers were native English speakers but were not otherwise part of the experiment. Electroencephalogram (EEG) data were collected by a cap, placed on the head, containing 32 electrodes, both for the infants as well as for the adult experimenter. Just as we tune a radio by selecting a frequency using a tuning knob, so we can also tune into brain waves. Two wave bands of electrical activity picked up from the caps were analysed: the Theta band with a frequency of 3-6 Hz (1Hz is a frequency of one wave per second), and the Alpha band with a frequency of 6-9 Hz. Both bands were recorded from the left and right sides of the cap of electrodes to enable an analysis of data from left and right sides. General Partial Directed Coherence (GPDC) is a standard technique that measures the influence that one electrode channel has on all the other electrode channels in the network between the adult and the infant for each gaze condition and the Alpha and Theta bands. The number and length of infant vocalisations during the experiment were also recorded.

In experiment 1, where the adult was only visualised on a video, the results showed that:

- the statistical difference between the Direct or Indirect gaze was significant for both the Theta and Alpha bands.
- Similarly, there was a statistically significant difference between Indirect and Direct-Oblique gaze for both Theta and Alpha bands.
- In the comparison between Direct and Direct-Oblique gaze, only the Alpha band was significantly different.
- The actual values for the GPDC data were smaller for the Indirect gaze i.e. no eye contact between infant and video of the adult.
- There were no significant differences in Infant vocalisations between the gaze conditions.

In experiment 2, the actual live, and not pre-recorded, gaze between the adult and the infant was measured on Theta and Alpha i.e. a bi-directional effect. The experiment showed that:

- In all four comparisons, the GPDC value obtained for Indirect gaze was significantly less than the value obtained for Direct gaze.
- The infant's brain is affected by the adult's Direct gaze and the adult's brain is affected by the infant's Direct gaze.
- In this experiment, the infant's vocalisations were correlated significantly with the infant to adult direction with Direct gaze from the adult, but not with the Indirect gaze of the adult.

The results from both experiments suggest that live Direct gaze from the adult to the infant is associated with interpersonal neural synchronisation. The oscillating Theta and Alpha waves move into phase alignment between the infant and adult during direct gaze.

These findings provide new information for early-learning research. Eye gaze may well become a key cue for learning in the infant from the parent; social feedback appears to be taking place in early learning, and bi-directional parent-infant neural synchrony may be a way to understand scaffold learning experiences in developing infant-parent interactions ('scaffold learning' meaning assembling together the main key building blocks of learning, in order to be the most effective). In summary, if a parent wants to gain the attention of the infant, eye contact will be an important part of the process of synchrony between the infant and parent. The infant will respond with its vocalization feedback.

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