What About The Children?

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RESEARCH SUMMARY

Neural circuits underlying mother's voice perception predict social communication abilities in children.

Abrams, D.A., Chen, T., Odriozola, P., Cheng, K.M., Baker A.E., Padmanabhen, A., Ryali, S., Kochalka, J. and Menon, V.
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This paper received widespread reporting in mainstream media. The authors sought to link the sensitivity towards human voice, learned by children from hearing their mother's voice, to the parts of the brain that are activated by their mother's voice and not another female voice. This auditory perception is sometimes referred to as recognition of an 'auditory face'. Recognition of mother's voice plays an important role in regulating behaviour and learning in the child. In stressful situations a child is calmed by hearing the mother's voice and the cortisol (a stress chemical) level is diminished whilst the oxytocin (a bonding chemical) level is increased. Both of these chemicals are released in the brain, but what are the neural pathways? How specific is the mother's voice compared with un-related female voices in affecting the child's response?

Functional magnetic resonance imaging (fMRI) was used to track the brain activity of 24 children, aged 7-12 years. All were right-handed, had an IQ >80, had no history of mental disorders, none were adopted and all were raised in homes that included their biological mother. Recordings were made of the biological mother's voice for three four-syllable nonsense words; these words lasted for 0.96 seconds. Recordings of the same words were also made by two female controls. Nonsense words were used to eliminate semantic systems in the brain from consciously processing information. The experiment had two endpoints:

1. To identify neural centres and circuits activated by the mother's voice in her child.
2. To explore differences in brain responses of the child to control voices that were acoustically similar to the biological mother's voices in terms of pleasantness and excitement.

The children recognised their biological mother's voice with 97% accuracy, compared with the control voice, for the nonsense words: only 3% misrecognised. Areas of the brain that responded preferentially to the mother's voice, compared with the control, were determined by subtracting the fMRI signal produced by the control voice from that produced by the mother's voice. This identified responses in parts of the child's brain that were attributed to a greater activation by the biological mother's voice. No region in the brain responded more to the female control voice than to the biological mother's voice, which always had a greater effect. Table 1 gives details of parts of the brain that responded more to the mother's voice.

Table 1. Regions of the child's brain increasingly activated by the biological mother's voice and the function of those regions.

Brain regions activated.	**Function of that region in information processing.**
The bilateral inferior colliculus, the primary mid-brain nucleus and the posteromedial Heschl's gyrus	This forms the auditory cortex, dealing with hearing
Superior temporal gyrus and superior temporal sulcus in the lateral temporal cortex	Voice selective regions, distinguishing between different voices
Medial temporal lobe including the left-hemisphere amygdala	The affect system, processing emotions
Bilateral nucleus accumbens, ventral striatum of the orbitofrontal cortex and ventromedial prefrontal cortex.	Part of the mesolimbic reward pathway concerned with perception of pleasure
Posterior medial cortex, including the precuneus, and posterior cingulate cortex.	Processes self-referential information: processing information that references one's own personal world and experiences
Multiple regions of the occipital cortex	Facial visual processing, recognising people
Dorsal anterior cingulate cortex and anterior insula	Part of the salience network that identifies priorities rather than background input

These research findings indicate a wide range of brain regions activated by the mother's voice and the complexity of the processing involved in voice recognition by the child to its mother. Many of these brain regions are connected as a speech-based network to regions responsible for social communication in the developing child. This research provides the ground work for further exploration of socially disrupted brain networks that arise, for example, in autism.

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