The Development of Predictive Coding in Young Children

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**BACKGROUND**

Brain function according to predictive coding theory...

Processing prediction error is taxing. To reduce neural bandwidth, the brain devotes itself to minimising prediction error over time. This is achieved through revising and optimising its internal model.

The neural architecture assumed to implement PC undergoes significant maturation across childhood. In particular, prolonged maturation of the prefrontal cortex thought to play a key role in tracking complex statistical regularities in the environment – may support increasingly sophisticated predictive brain function across childhood.

**METHOD**

- 37 children (19 older, M = 6yrs; 18 younger, M = 4 yrs)
- Child MEG
- Multi-deviant auditory oddball paradigm
- Rapaport et al., 2019, JoVE

Mismatch Field (MMF) = (brain response to deviants) – (brain response to standards)

- Under predictive coding, each brain response is understood as an index of prediction error: the worse the brain’s prediction, the larger the prediction error (or ‘neural ‘surprise’), and the larger the amplitude of the evoked response.
- Statistical analysis: Non-parametric cluster-based random permutation tests (α-level = 0.05).

**RESULTS**

- Older children showed a significant MMF in the right A1 and bilateral STG.
- Younger children showed a sig. smaller MMF between 230—346 ms (p = 0.02) compared to the older children. This suggests that the older children were better able to predict the repetitive standards (relative to the more-random deviants) as indicated by a larger MMF amplitude.

**SENSOR-LEVEL ANALYSIS**

- Hypotheses: If the older children are able to better predict the ‘standards’ relative to the ‘deviants’, we should see a larger difference in the evoked response between the two conditions, as indexed by a large MMF amplitude.
- By contrast, if the younger children are relatively worse at predicting both the ‘standards’ and the ‘deviants’, we should see a smaller difference in the evoked response between the conditions, as indexed by a smaller MMF amplitude.

**SOURCE-LEVEL ANALYSIS**

We constrained the analysis to 6 regions involved in adult MMF generation (listed in hierarchical order from low to high): bilateral primary auditory cortices (A1), superior temporal gyri (STG), and inferior frontal gyri (IFG).

- Older vs younger MMF

Hypotheses. (1) We expected all children to show an MMF in the lower-order A1 and STG regions. (2) If the frontal cortex becomes increasingly involved in the prediction of sensory signals (and responding to prediction errors) then we might expect the older children to show a larger MMF amplitude in the IFG compared to younger children.

NB. The black lines (____) show the significant MMF clusters for each group at each ROI, separately.

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