AN FMRI STUDY OF PROBABILISTIC SEQUENCE LEARNING REVEALS AGE-RELATED DIFFERENCES IN ACTIVATION

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INTRODUCTION

- Probabilistic sequence learning enables the detection of environmental regularities.
- The developmental trajectory of implicit sequence learning is relatively unknown.
- A prior fMRI study of implicit sequence learning in children (Thomas et al., 2004) reported age-related differences in functional neuroimaging and behavioral measures of implicit sequence learning. Thus, it is not known whether activation differences are observed without performance differences.

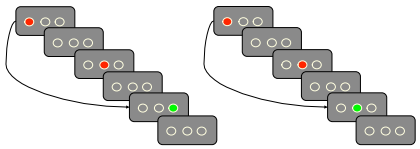
- **Question:** Does the neural substrate of probabilistic sequence learning differ for children and adults in the absence of age-related differences in behavioral measures of learning?

DESIGN

- Participants: 12 children 7-12 years (M = 9.97, SD = 1.2) and 10 adults 18-20 years (M = 18.8, SD = .6)
- Participants completed three runs of the Triplets Learning Task (Howard et al., 2008) lasting 6:20 min and comprising 135 trials each
- Event-related design; stimuli presented in fixed, pseudorandom order with variable ITI determined using OptSeq2
- Each trial comprised a three-event sequence (2 cues, 1 target)
- Participants responded to target location with right hand
- Location of the first cue probabilistically predicted location of the Target
  - High Probability Trials
  - Low Probability Trials
- Cue and Target location counterbalanced

High Probability Trial (80% of Trials)

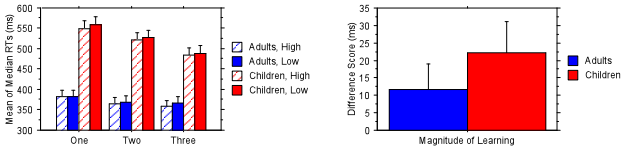
Low Probability Trial (20% of Trials)



FMRI PARAMETERS

- Siemens 3T Trio magnet, T2* sensitive gradient EPI acquisition
- 152 images/run, 42 3.7 mm axial slices, TR 2500 ms, TE 30 ms, 90˚ flip angle, FOV: 256 x 256, 4 mm in-plane resolution
- Data analysis in SPM5: Slice-time correction, motion correction, spatial normalization,8mm spatial smoothing
- Random effects analysis with Group as a between subjects factor and Run and Probability as within-subjects factors
- All main effects and interactions thresholded at p < .005, uncorrected, k = 20

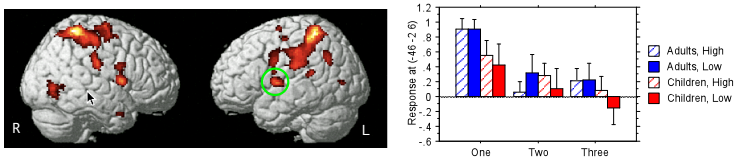
BEHAVIORAL RESULTS



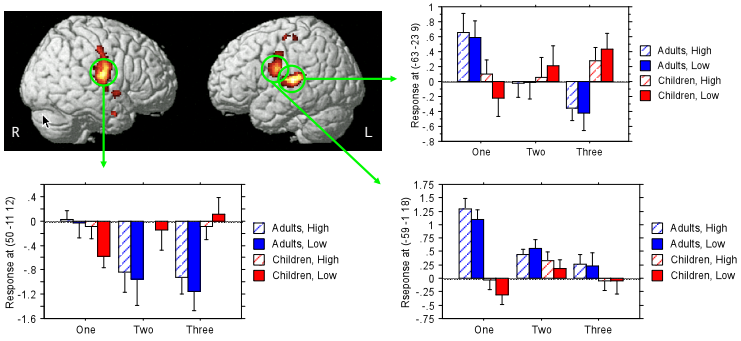
- Overall performance was faster (p < .0001) and more accurate (p = .05) for adults than children. Overall accuracy was above 84% for all participants.
- While overall performance was faster with practice (Main Effect of Run, p < .0001), practice effects were smaller for adults than children (Group x Run interaction, p = .01).
- Performance was faster on High Probability than Low Probability trials (p = .008) indicating that learning was observed. Importantly, however, magnitude of learning did not differ between groups p = .37).

FMRI RESULTS: PRACTICE EFFECTS

As expected, practice yielded overall changes (i.e., a main effect of Run) in activation for regions including motor, premotor , parietal, and temporal cortex. These changes were typically decreases in activation with practice.

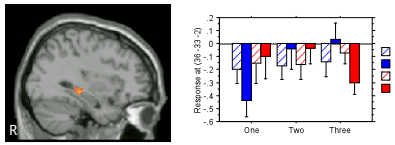


Practice-related changes were larger for adults than children (i.e., Group x Run interactions). Regions in bilateral precentral and superior temporal gyri showed decreases in activation with practice for adults and either increases or no change in activation with practice for children.

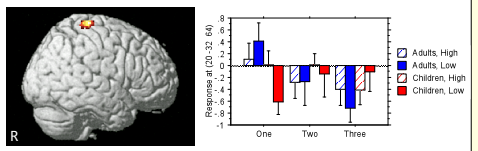


FMRI RESULTS: PROBABALISTIC LEARNING

A region in right caudate tail showed early deactivation for adults and late deactivation for children on Low Probability trials (i.e., Group x Run x Probability interaction).



Bilateral regions in motor cortex (left hemisphere not shown) showed early activation for adults and early deactivation for children on Low Probability trials.



SUMMARY

- Regions in bilateral motor, premotor, parietal, and temporal cortex showed overall decreases in activation with practice.
- Adults showed greater practice-related decreases in activation of bilateral premotor and temporal regions.
- Comparable levels of learning were achieved for children and adults via differential reliance on motor and striatal regions.
- Patterns of activation in bilateral motor cortex and right striatum may suggest developmental differences in the ways in which probabilistic information shapes learning in children and adults.

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- Thomas, KM, Hunt, RH, Vizueta, N, Sommer, T, Durston, S, Yang, Y, Worden, MS. (2004). Evidence of developmental differences in implicit sequence learning: an fMRI study of children and adults. *Journal of Cognitive Neuroscience, 16*, 1339-1351.
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