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Hippocampal Learning and Number Processing in Young Children

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Introduction

- Children can visually perceive and quantify a small number of items in a set (configuration) by either subitizing or recognizing the overall spatial configuration.
- Subitizing is defined as the rapid and accurate enumeration of a small set of objects.
- The hippocampus has been shown to play a role in statistical learning, which is the rapid means of extracting regularities from the environment.
- The use of either strategy to quantify suggests a difference in learning.
- Previous studies have established the intraparietal sulcus'(IPS) role in non-symbolic and symbolic numerical processing.
- How does repeated exposure to spatial patterns affect functional connectivity with the IPS and hippocampus?
- Can exposure to specific spatial patterns lead to generalized learning of novel configurations?

Hypotheses

- We predicted that IPS – early visual cortex functional connectivity would be lower post-training because of a lesser reliance on IPS for previously seen patterns.
- We would observe training effects in the temporal correlation between the hippocampus and the early visual cortex (occipital pole) for configurations participants trained on.

Methods

Participants

- 16 young children (5 female).
- Ages: 5 – 8 years.

Mock Scan

- The child participant was introduced to the sounds and environment they would experience while completing the fMRI task.
- The participant's ability to complete the fMRI task was tested. If the child did not feel comfortable with completing the mock scan they were not asked to continue participating in the study.

Pre-Scan

- Participants indicated the number of stars by pressing the correct number of fingers on either of the two button boxes in the scanner.
- Tasks had two conditions – configurations taken from Fingu and novel configurations.
- Instead of fruit, the tasks had stars in varying configurations, ranging from 3 to 6.
- Participants indicated the number of stars by pressing the correct number of fingers on either of the two button boxes in the scanner.

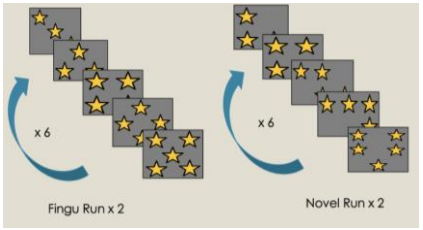
Fingu

- Between the pre-scan and post-scan, participants trained on Fingu on an Ipad for one week at home.
- Fingu displays configurations of 1 – 10 fruits moving across the screen and players must indicate how many fruits they see by pressing down the same number of fingers.
- Parents were instructed to let the child have at least 10-15 minutes of play time every day.

Post-Scan

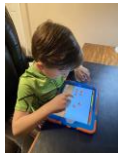
- The participant completed the same fMRI tasks that were complete in the pre-scan, but with different configurations.

Design



fMRI Task

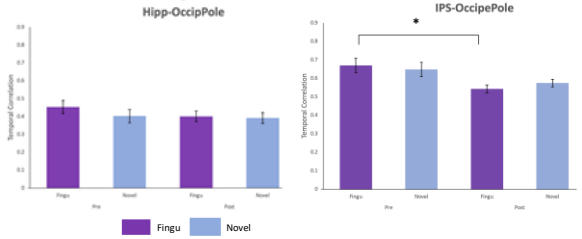
- 4 interleaved runs – each run had 6 blocks
- 2 runs with Fingu configurations (familiar) and 2 runs with novel configurations (unfamiliar).



Example participant playing *Fingu*

Example level from *Fingu*

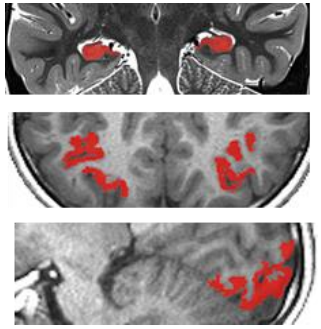
Preliminary Results



Shows the mean temporal correlations between IPS and Occipital Pole, and between Hippocampus and Occipital Pole. In both graphs, the first two bars represent Pre-training and the last two represent Post-training. Results show a significant decrease in temporal correlation between IPS and occipital pole post-training.

* $p < .05$

ROI's



Hippocampus

Intra-parietal Sulcus (IPS)

Occipital Pole

Discussion

- Decreased functional connectivity between the IPS and occipital pole suggests lesser reliance on the IPS for patterns, post training.
- Further analyses needs to be done to explain the lack of significant differences in the hippocampus
- The lack of significance in correlation between the hippocampus and the visual cortex could also suggest that the trained patterns become more specific over time.
- Further analyses on the MTL (medial temporal lobe) and visual cortex are required to tease apart the effect of trained patterns.

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