NEURAL BASIS OF IMPLICIT SEQUENCE LEARNING IN A PROBABILISTIC TRIPLETS LEARNING TASK

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INTRODUCTION

IMPLICIT LEARNING is the acquisition of knowledge about environmental regularities (e.g. where or when something is likely to occur) without explicit awareness.

TRIPLETS LEARNING TASK (TLT)

- Perceptual sequence learning task without motor sequencing (Howard et al., under revision)
- Complement to traditional Serial Reaction Time Task (SRTT) (Nissen & Bullemer, 1987)

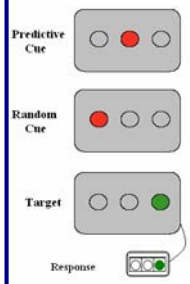
AIM: To identify brain activation associated with learning on a new implicit probabilistic sequence learning task: Triplets Learning Task

METHOD

PARTICIPANTS

- 11 young adults (18.8 ± 0.6 years; 6 female)
- 10 young adults in Run 3 due to scanner malfunction

EVENT-RELATED TRIPLETS LEARNING TASK



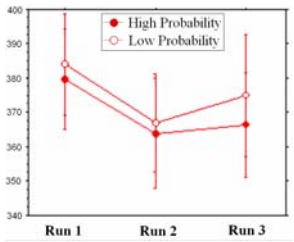
- Series of discrete, three-event sequences or 'triplets'
  - 2 cues (predictive, then random) and 1 target per trial
  - Respond only to target event (1 of 3 locations) with right hand
- 2nd order structure: Unbeknownst to participants, location of 1st cue predicts target location
  - In one location on 80% of trials (High Probability Condition)
  - In another location on 20% of trials (Low Probability Condition)

fMRI PARAMETERS

- 3T Seimens Magnet, T2* sensitive gradient EPI acquisition
- Three 6.5 minute runs
- 152 images/run, 42 axial slices; voxel size = 4.0 x 4.0 x 3.7 mm
- TR = 2500 ms, TE = 30ms, 90˚ flip angle, FOV = 256
- Data Analysis in SPM5 (Realignment, Spatial Normalization to MPRAGE, Spatial Smoothing {8mm})
- Random-effects group averaging:
  - High Probability – Low Probability contrast (Response to Predictability)
  - Low Probability – High Probability contrast (Response to Novelty)
  - Correlational analyses
  - p < .005 uncorrected, extent 15 voxels

BEHAVIORAL RESULTS

Reaction Time (ms)
(Mean)

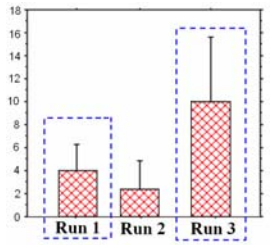


Reaction time improved over time (Skill learning): F(2,18)=3.68, *p*= .05

Reaction time improved more for High relative to Low Probability trials (Triplet learning): F(1,9)=4.11, *p*=.07

Mean Accuracy: 98.6% (SD=.03) with no effect of Skill or Triplet learning

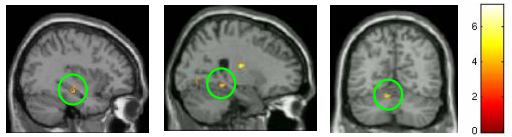
Reaction Time (ms)
(Difference scores, Low – High)



NEUROIMAGING RESULTS

RUN 1 ACTIVATIONS

Contrast: High Probability – Low Probability
Response to Predictability



Hippocampus x = -20 | Parahippocampal Gyrus (BA35) x = -38 | Cerebellum y = -60

RUN 3 ACTIVATIONS

Contrast: Low Probability – High Probability
Response to Novelty

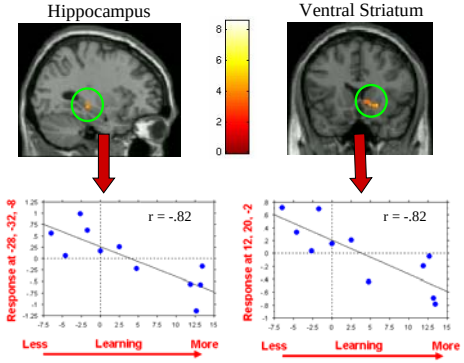
DLPFC (BA46) y = 42 | Inferior Frontal Gyrus (BA47) y = 22 | Superior Parietal Lobule (BA7) y = -36

RUN 1 CORRELATIONS

Triplets Learning X Activation

x = -32
Hippocampus

y = 20
Ventral Striatum



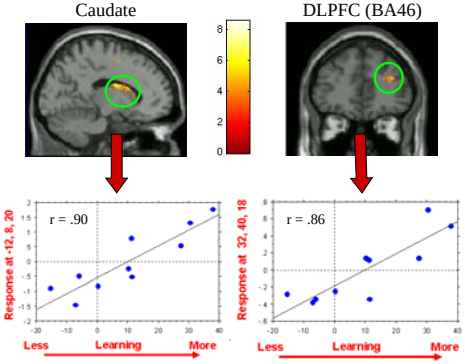
x-axis: Low – High (mean RT)
y-axis: Activation from High – Low Probability contrast

RUN 3 CORRELATIONS

Triplets Learning X Activation

x = -12
Caudate

y = 40
DLPFC (BA46)



x-axis: Low – High (mean RT)
y-axis: Activation from High – Low Probability contrast

SUMMARY AND DISCUSSION

BEHAVIOR

- Skill and Triplet learning

NEUROIMAGING

- Greater response to predictability (most often repeated sequences) in Run 1
- Greater response to novelty (least often repeated sequences) in Run 3

	RUN 1 ACTIVATIONS	RUN 3 ACTIVATIONS
Response to Predictability	• Medial Temporal regions • Cerebellum	None
Response to Novelty	• Parietal region (BA7)*	• Frontal regions • Parietal region (BA7) • Temporal region (BA21)*

* data not shown

CORRELATIONS WITH LEARNING SCORES

- Revealed changes in neural substrates underlying early and late training
  - Learning negatively correlated with hippocampus and striatum activation in Run 1
  - Learning positively correlated with caudate and DLPFC activation in Run 3

- These findings are similar to previous research showing medial temporal activation and frontostriatal involvement in probabilistic learning and extend them to a new probabilistic sequence learning task.

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