THE ROLE OF WHITE MATTER INTEGRITY IN TWO FORMS OF IMPLICIT LEARNING

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INTRODUCTION

IMPLICIT LEARNING: Non-conscious acquisition of regularities from the environment (Frensch, 1998)

TWO FORMS OF INTEREST:

- Differ in the type of regularity to be learned
- Rely on different gray matter regions, as seen in multiple functional imaging and patient studies (Chun & Phelps, 1999; Prull et al., 2000)

IMPLICIT SEQUENCE LEARNING	IMPLICIT SPATIAL CONTEXT LEARNING
Regularity across time	Regularity in spatial layout
Frontal (DLPFC, premotor, supplementary motor) Striatum (caudate, putamen) Cerebellum	Hippocampus Parahippocampal gyrus (entorhinal, perirhinal, parahippocampal cortices)

AIM: Do the two forms of implicit learning relate to white matter integrity from distinct neural regions?

METHOD

PARTICIPANTS

- 14 young adults (18.9 ± 0.7 years; 9 female)

GENERAL PROCEDURE

- DAY 1: Diffusion Tensor Imaging (DTI)
- DAY 2: Alternating Serial Reaction Time (ASRT)
- DAY 3: Spatial Contextual Cueing Task (SCCT)

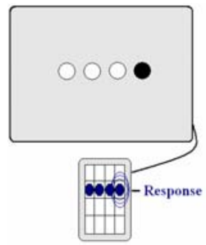
DTI METHODS

- 3T Siemens Trio
- One EPI sequence acquired per participant
  - Diffusion weighted gradients b=0 and b=1000 s/mm^2 applied in 35 orthogonal directions
  - 55 axial interleaved slices
  - 2.5 mm^3 spatial resolution
  - TR/TE=7700/100ms
  - FOV=240x240 mm
- Data processed with FMRIB's diffusion toolbox (Behrens, 2003; Smith et al., 2004)
  - Eddycorrect: corrected eddy current distortion
  - BET binary brain mask: limited tensor fitting to brain space
  - DTIfit: independently fit diffusion tensors to each voxel
- Fractional Anisotropy (FA) maps derived from eigenvalues of the diffusion tensor
- Voxel-wise whole brain positive correlations between individual measures of FA and last epoch learning scores conducted in SPM2 ($p < .03$, k = 500)

SEQUENCE LEARNING

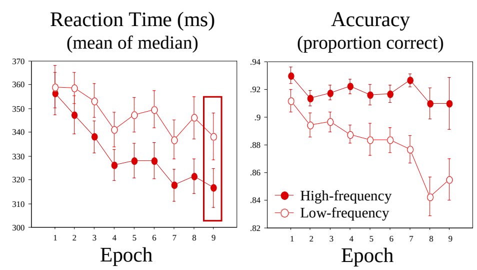
ASRT TASK:

- Respond to stimuli at 1 of 4 locations with right hand
- 2nd order sequence structure
  - e.g. 1r2r3r4r
  - 1, 2, 3, 4 = target location follows a repeating pattern
  - r = target location is randomly determined



BEHAVIORAL ANALYSIS:

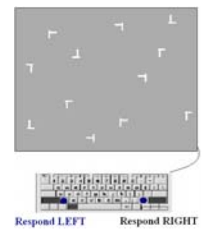
- Last trial of high-frequency (e.g. 112) and low-frequency (e.g. 113) triplets compared across 9 epochs (45 sequence repetitions per epoch)



SPATIAL CONTEXT LEARNING

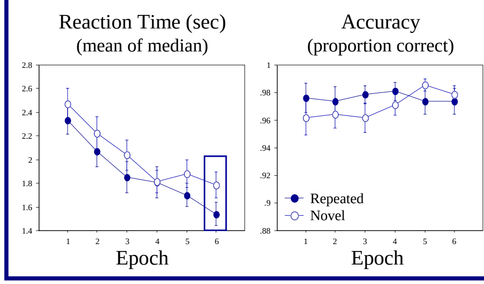
SCCT TASK:

- View arrays of 11 distractors (rotated, offset L's)
- Respond to orientation of target (horizontal T)
- Spatial contextual regularity
  - 6 repeated arrays: distractors predict target location, not response
  - Novel arrays: generated each trial



BEHAVIORAL ANALYSIS:

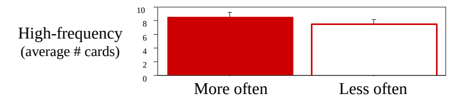
- Repeated and novel arrays compared across 6 epochs (5 exposures to each repeated array per epoch)



IMPLICITNESS

ASRT TASK:

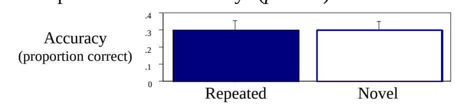
- Recognition task: High-frequency triplets equally sorted as occurring more and less often ($p > .48$)



- Post-experiment interview: No participant accurately described the regularity

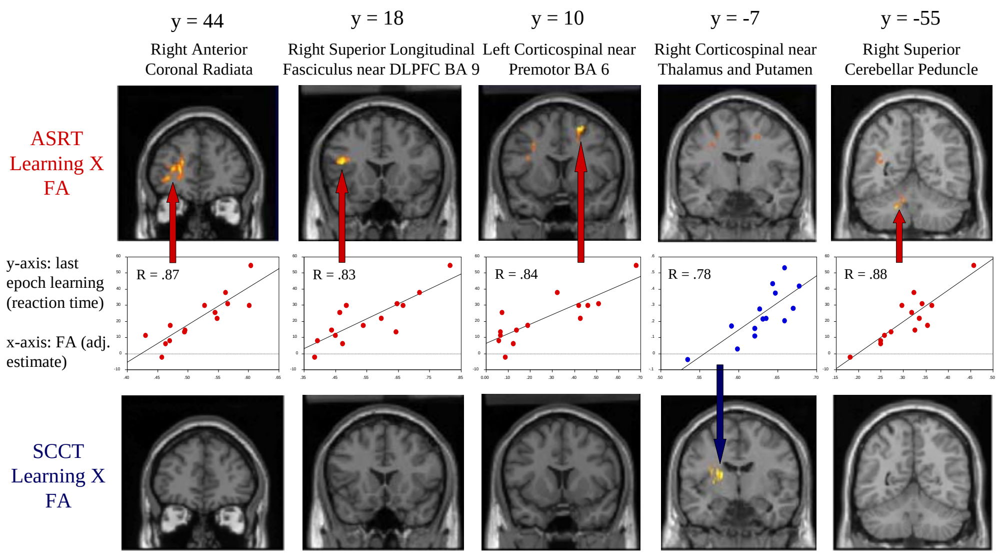
SCCT TASK:

- Recognition task: Equal recognition of target quadrant for repeated and novel arrays ($p > .99$)



- Post-experiment interview: Five participants felt some arrays were familiar

VOXEL-WISE WHOLE BRAIN CORRELATIONS



SUMMARY AND DISCUSSION

- Superior learning in the ASRT task was related to higher white matter integrity in:
  - Frontal regions adjacent to right dorsolateral prefrontal (DLPFC) and right premotor cortices, and the cerebellum – consistent with activation patterns from functional imaging studies of implicit sequence learning
  - Parietal and posterior corpus callosum regions (data not shown) – involved in perceptual-motor learning and interhemispheric transfer, respectively
- Superior learning in the SCCT task was related to higher white matter integrity from the corticospinal tract – involved in motor aspects of the task
- These findings are consistent with previous research showing that implicit sequence learning and implicit spatial context learning rely on different neural systems
- Future analyses will use tractography to examine the white matter networks involved

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