Correlated changes in brain functioning and cognitive performance are marked by individual differences

IEEE Data Bank Challenge 2017

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Hypotheses

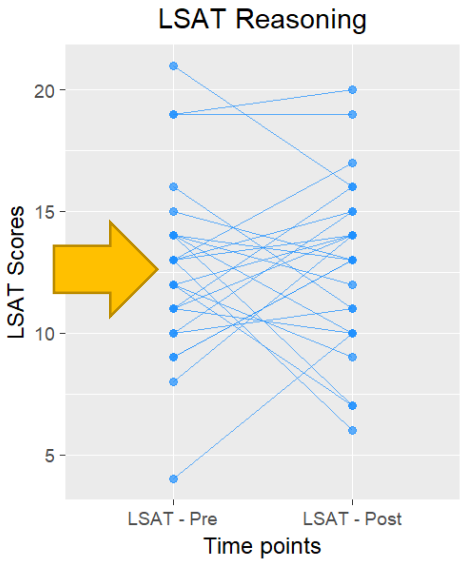
1. Individual differences exist in *cognitive performance*
    - Jaeggi, Buschkeuhl, Shah, & Jonides (2014)

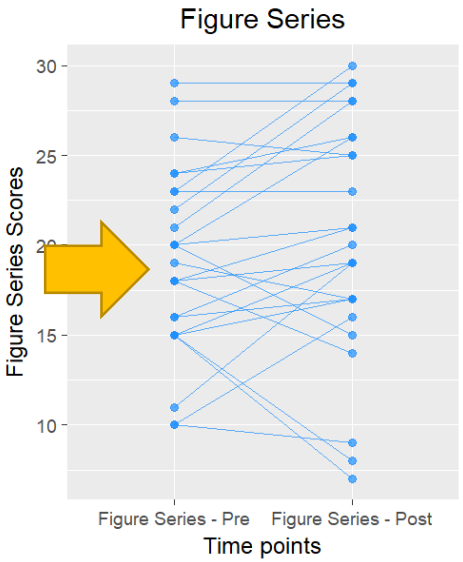
2. Individual differences exist in *brain functioning*
    - Raz et al. (2005)

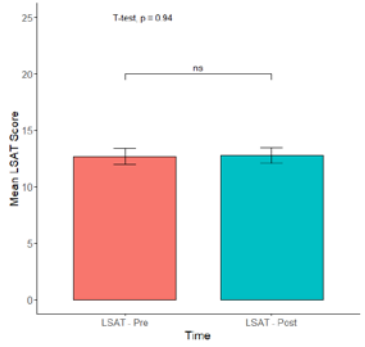
3. These changes are *correlated* in this study
    - Kane & Engle (2002)
    - Raz et al. (2010)
    - Kanai & Rees (2011)

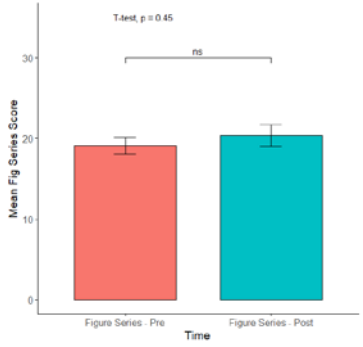
INITIAL ANALYSES

REAL DATA

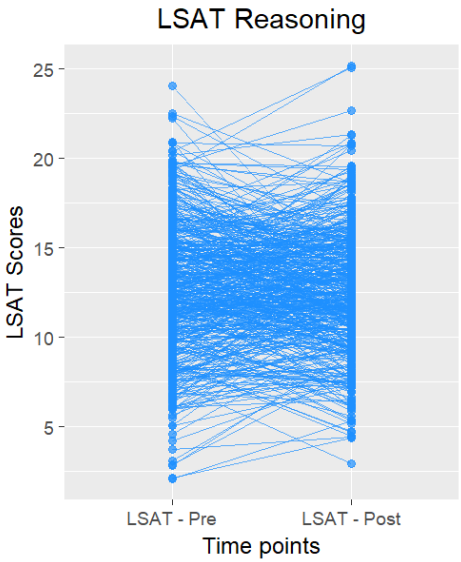


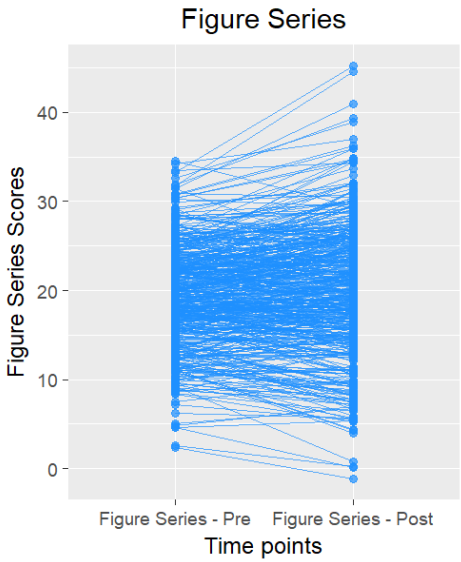


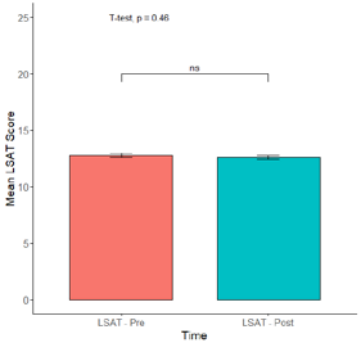


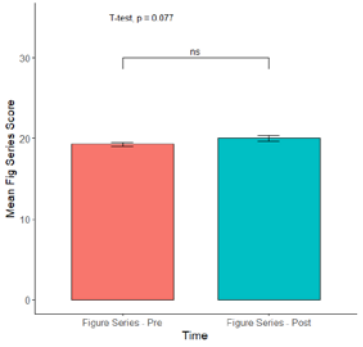


SIMULATED DATA

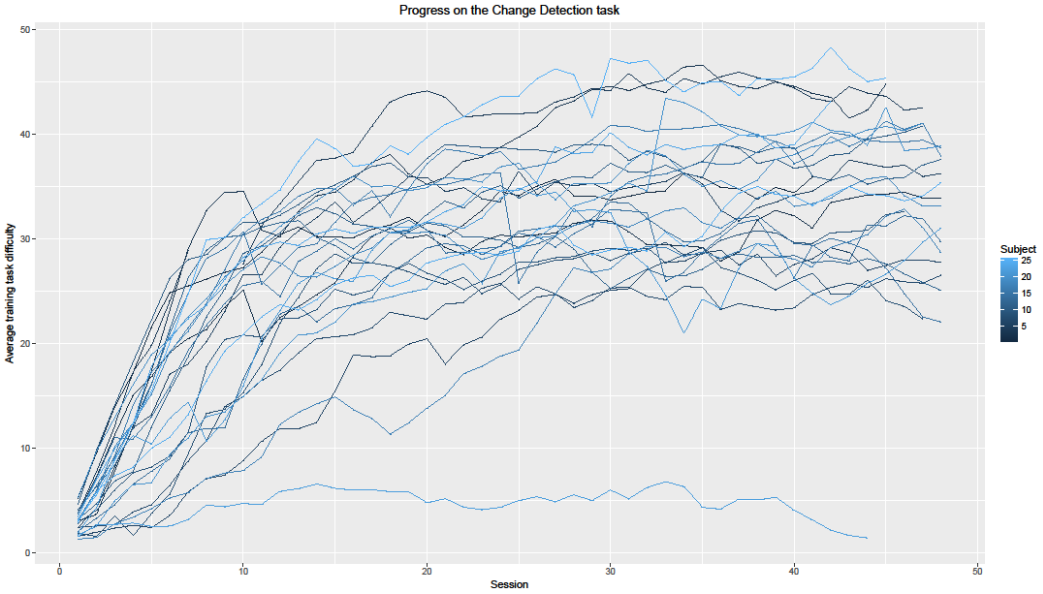


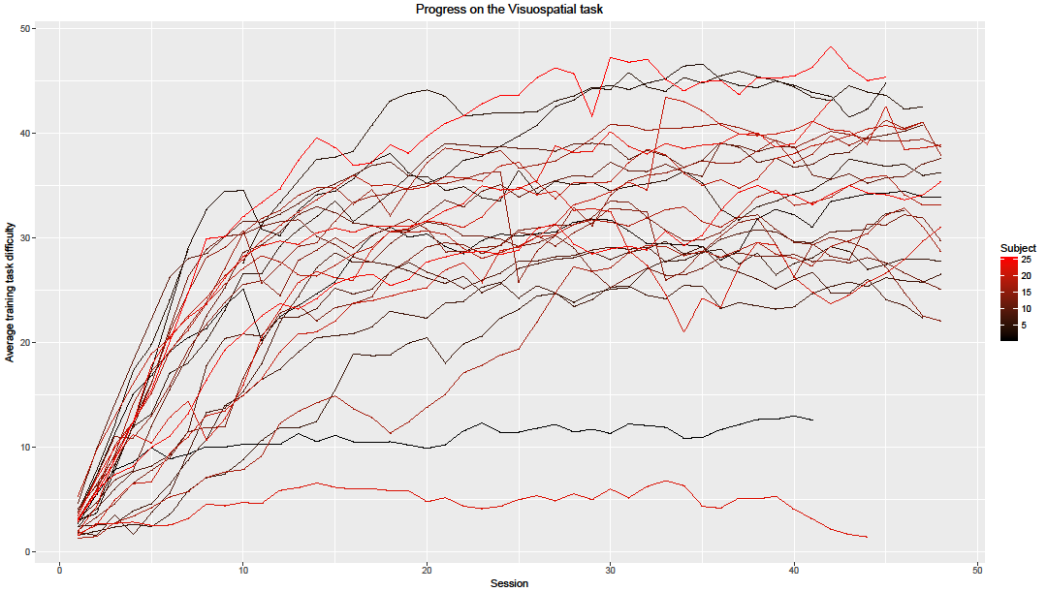




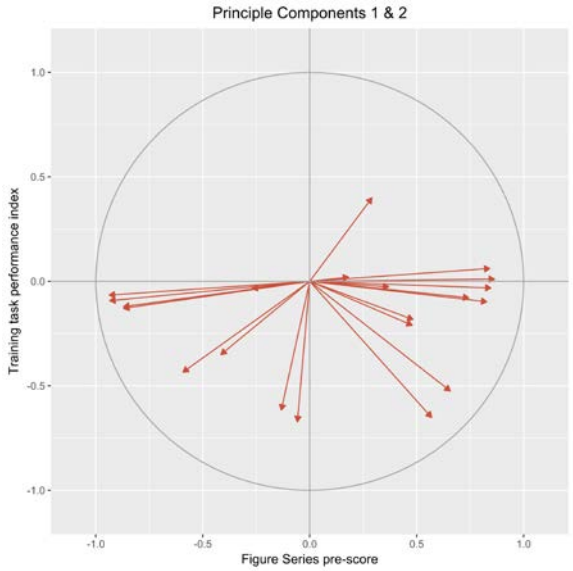


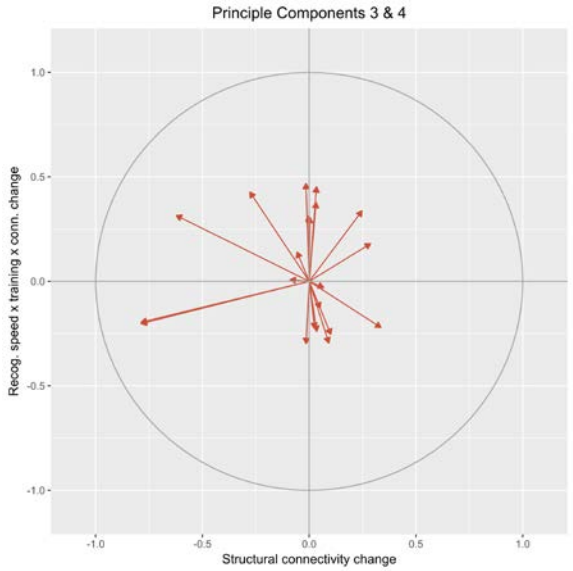
TRAINING CURVES

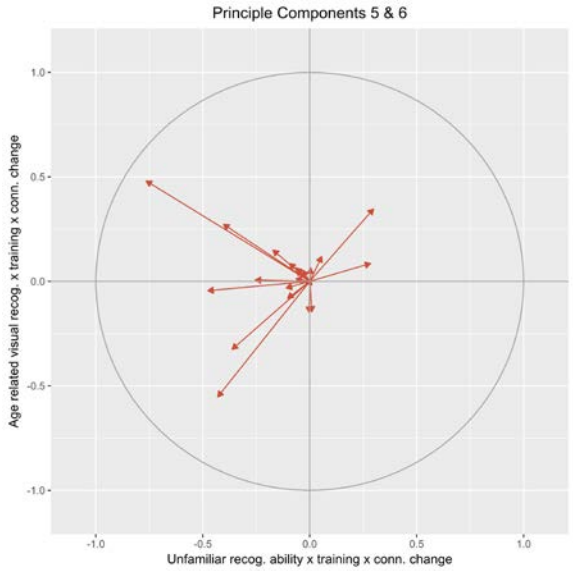


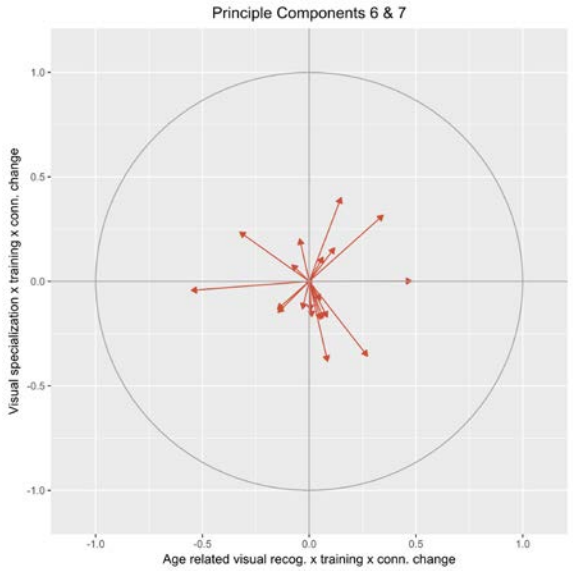


PRINCIPLE COMPONENTS









First 7 PCs explain over 93% of variance

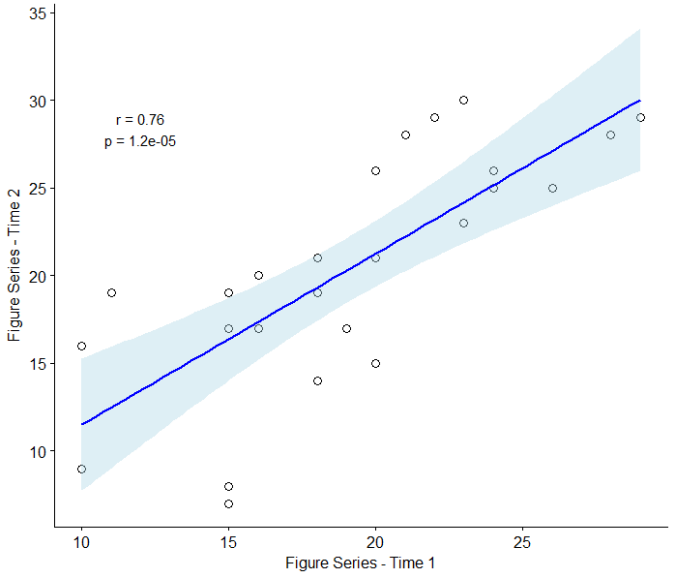
1. Latent recognition speed
2. Latent ability to recognize unfamiliar objects/symbols
3. Speed of progression through the test battery
4. Age related improvements in object recognition
5. Trade-offs in effort for one test vs. another
6. Specialization for visual vs. verbal processing
7. Age related declines in processing ability

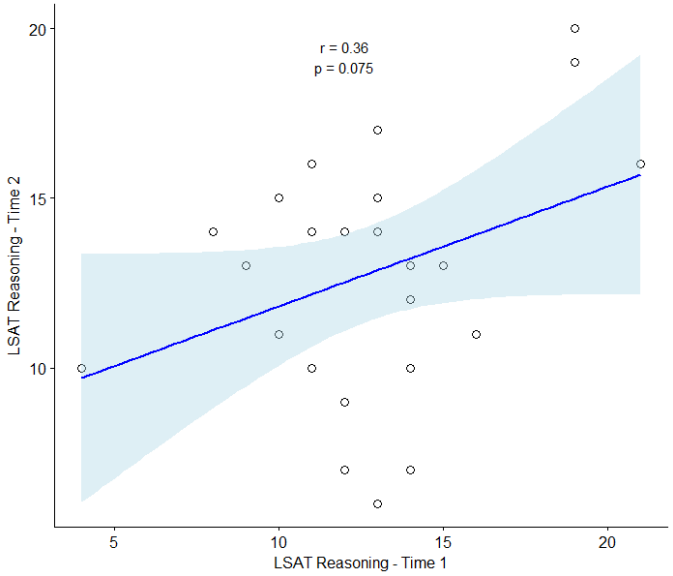
SAMPLE SPLIT

Figure Series

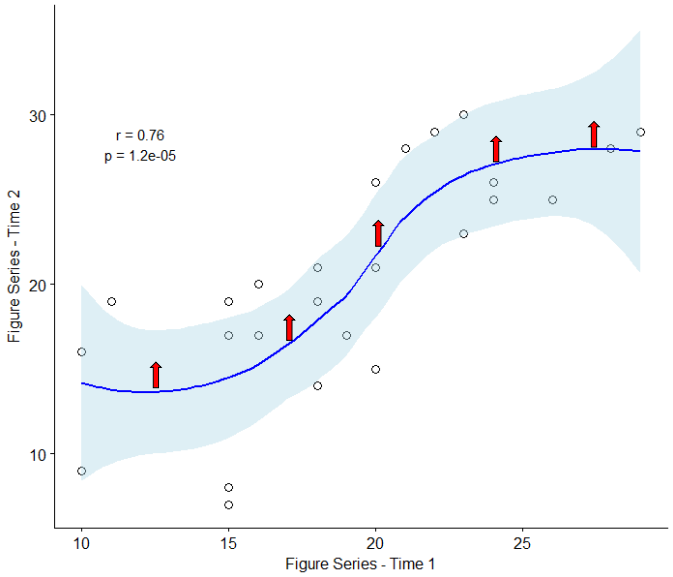
LSAT Reasoning

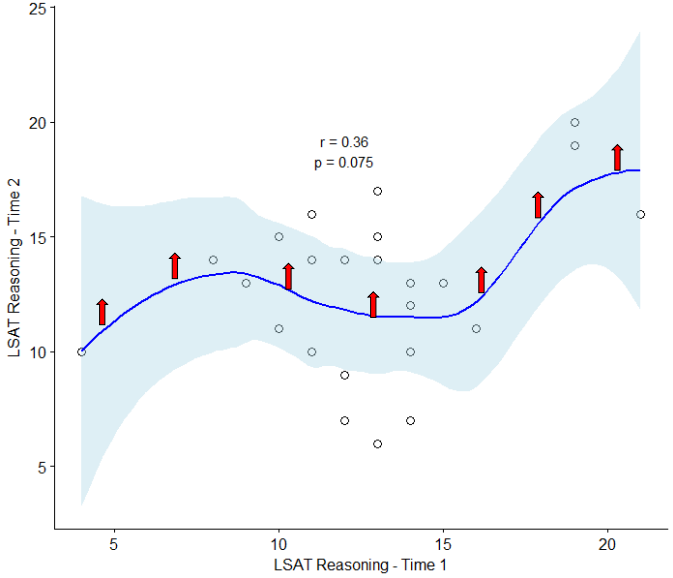
Linear





Loess





FA – PRE vs POST

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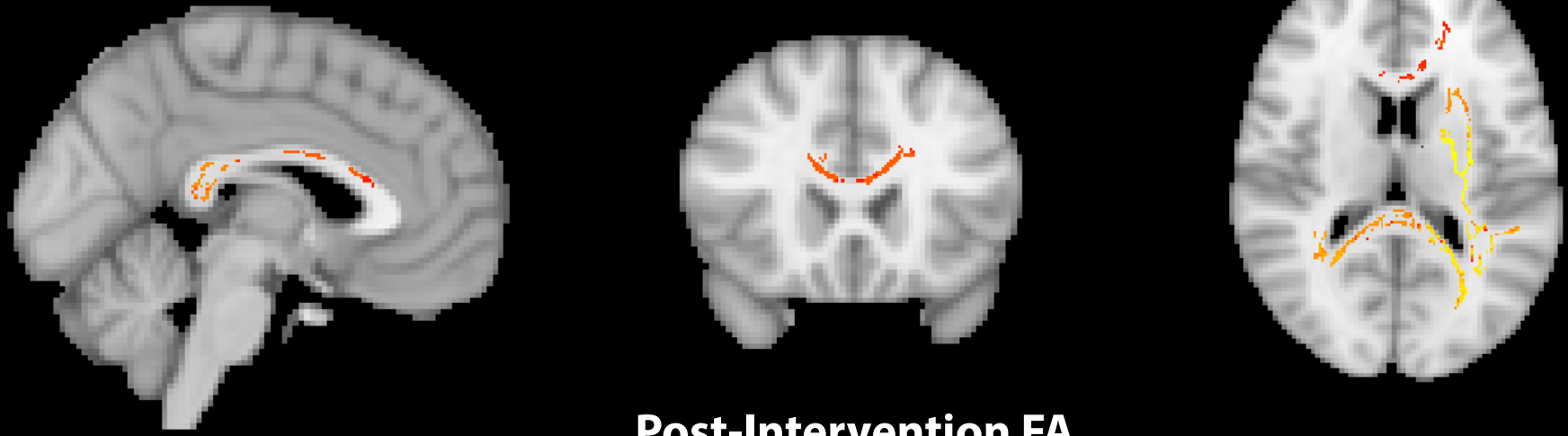
Pre-Intervention FA

(t-test, sample split)

$\alpha < 0.1$



Post-Intervention FA

(t-test, sample split)

$\alpha < 0.1$

Via FSLeyes

CINGULATE CORTEX

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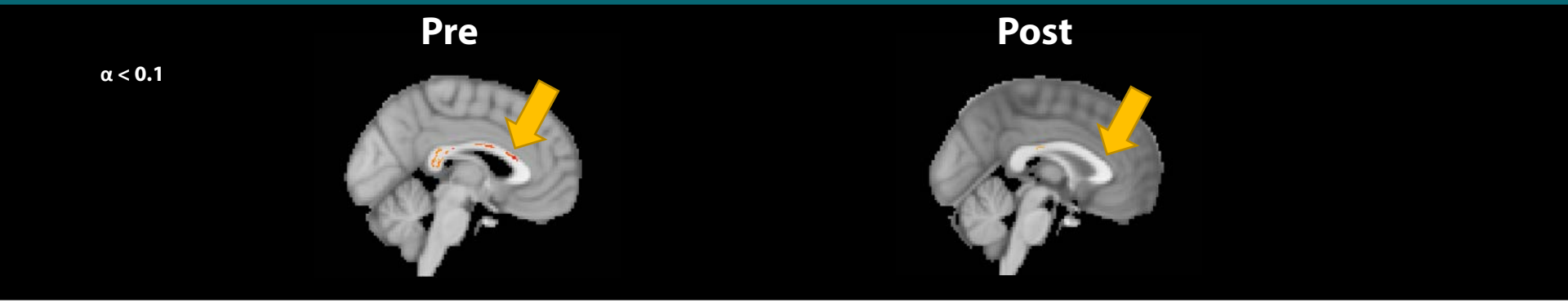


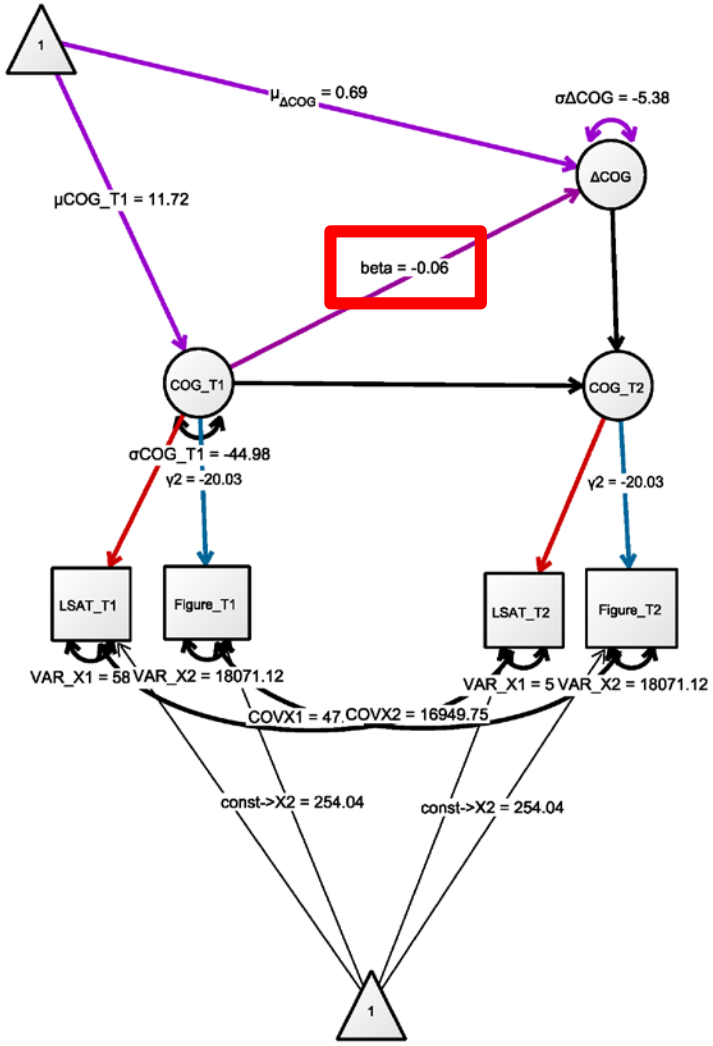
Regression using FA - caudal anterior & posterior cingulate cortices

Coefficients

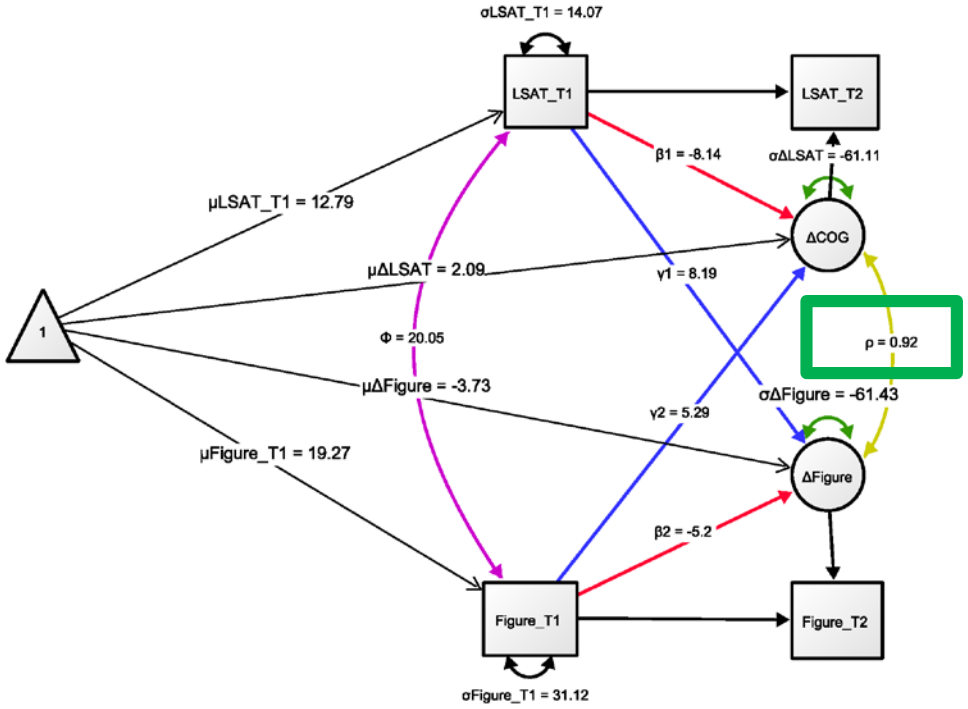
	Estimate	*t*-value	*p*-value
(Intercept)	-16.43	-1.18	0.26
Figure Series pre-score	1.04	5.51	< 0.01 ***
Training task performance index	2672.39	1.38	0.19
Structural connectivity change	0.02	2.60	0.02 *
Recog. speed x training x conn. change	-1.81	-2.59	0.03 *
Unfamiliar recog. ability x training x conn. change	-0.39	-0.80	0.44
Age related visual recog. x training x conn. change	-1.35	-2.43	0.03 *
Visual specialization x training x conn. change	2.09	0.67	0.52
Age related processing x training x conn. change	-1.58	-1.76	0.11
Recognition speed	0.23	2.51	0.03 *
Ability to recognize unfamiliar objects	0.16	1.78	0.10
Age related improvements in visual recog.	0.24	2.56	0.03 *
Specialty for visual vs. verbal processing	-0.45	-1.34	0.21
Age related decreases in processing ability	0.14	1.42	0.18

LCSMs – Fig Series & LSAT

Latent Change Model (COG)[1]



Correlated Latent Change Model (COG)[2]

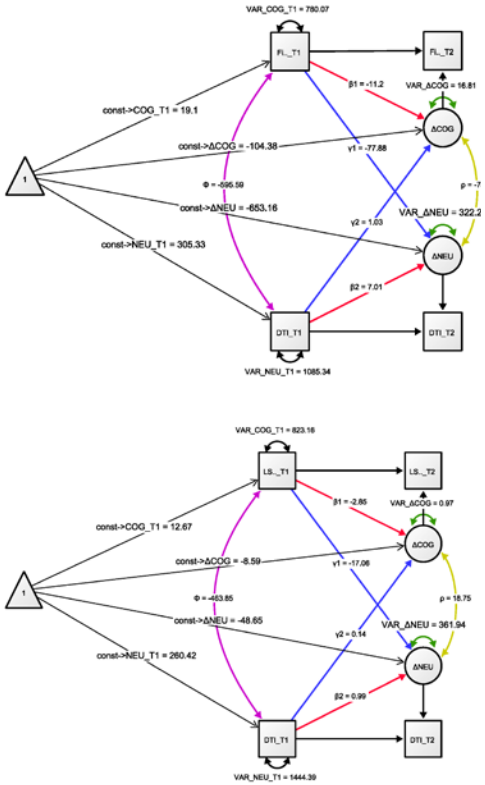


[1] Significant negative beta: Lower T1 COG scores = greater positive change in COG scores

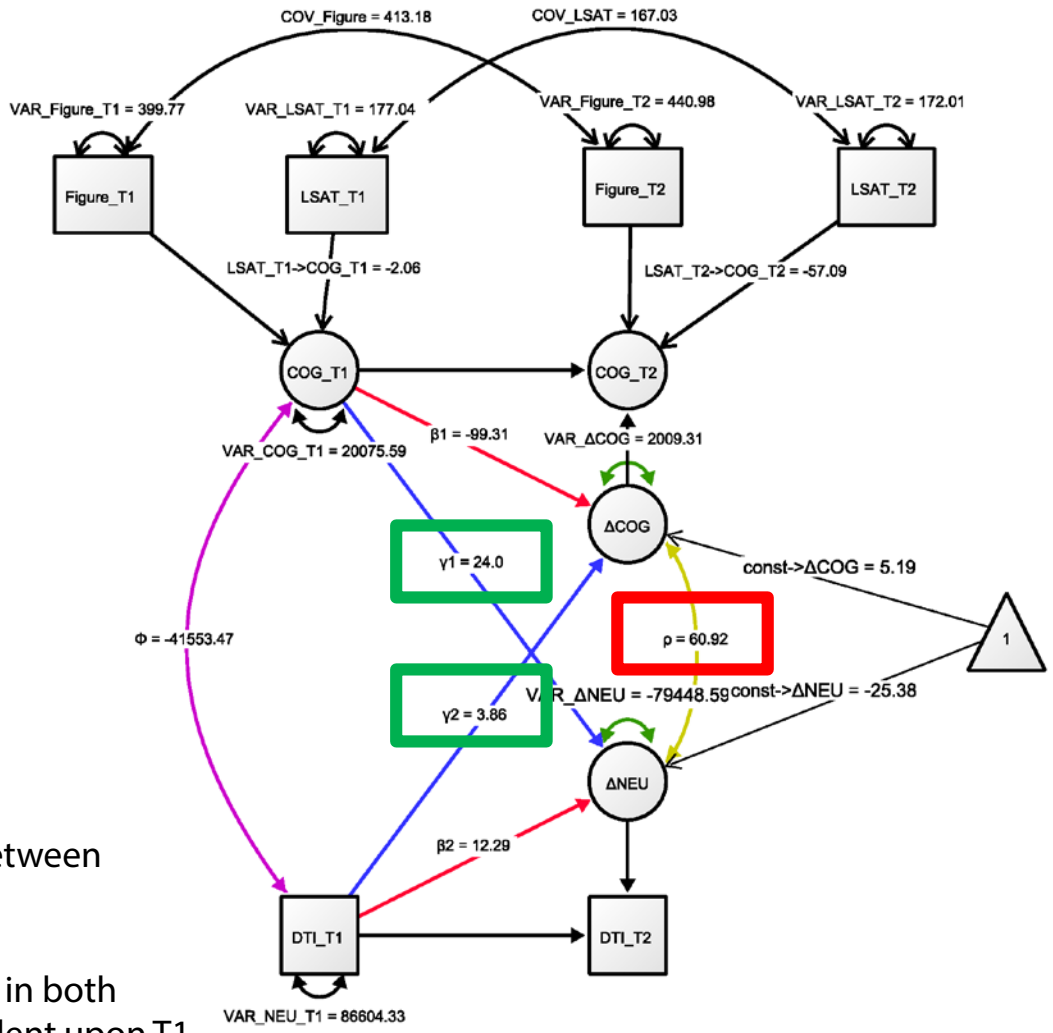
[2] Significant positive rho: changes in both LSAT and Figure Series are correlated with each other (when controlling for all other variables)

LCSMs – COG & NEURO

Separate Measures[1a,b]



Combined Measures[2]



[2] Significant positive rho: Correlated changes between cognitive and neuro latent variables

[2] Significant cross-couplings (gamma): Changes in both cognitive and neuro latent variables are dependent upon T1 neuro and cognitive scores, respectively

QUESTIONS