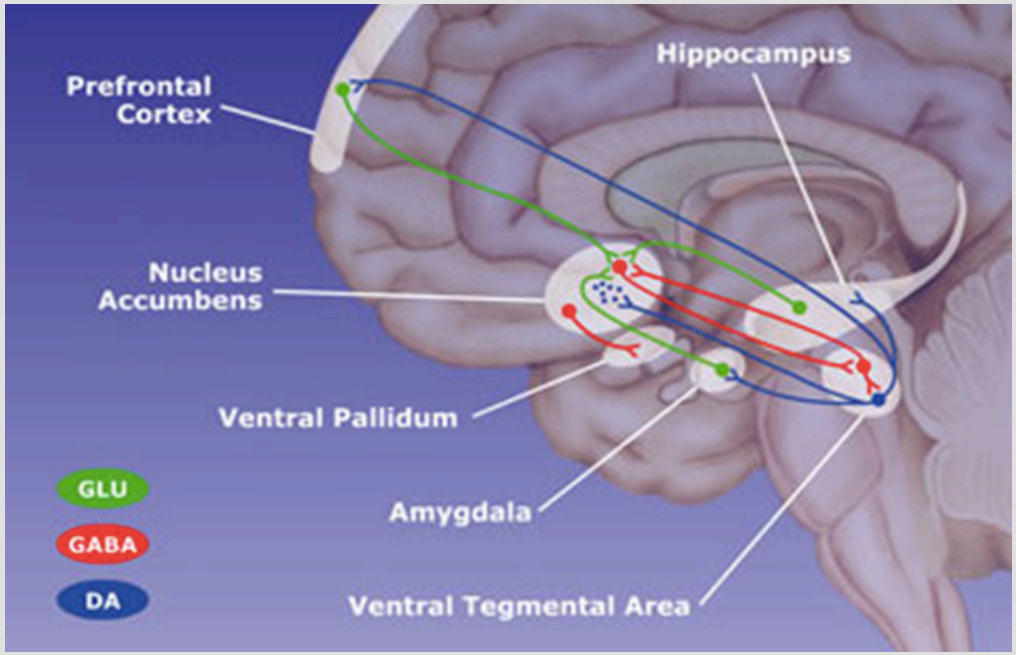
White matter pathways associated with selective recall

Prioritization

With a limited mnemonic capacity, it makes sense to prioritize that which has the highest value

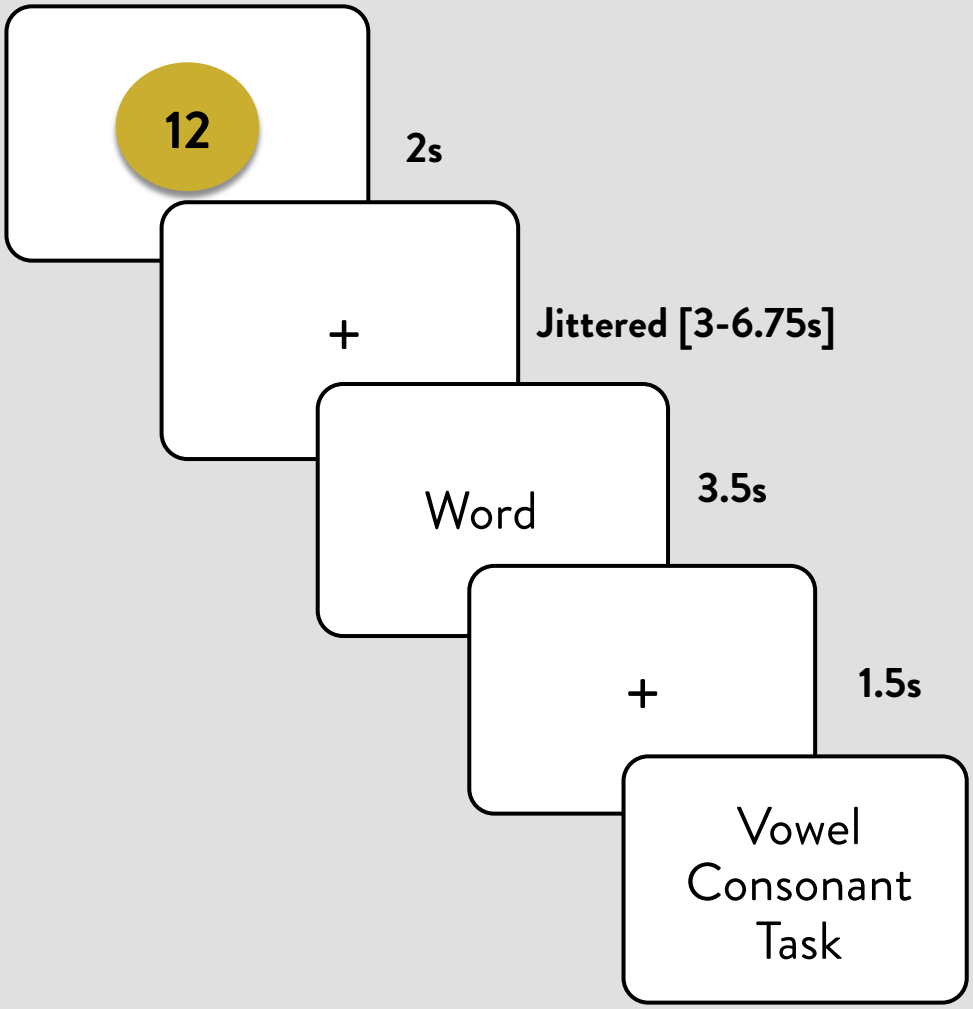
Individuals show widespread variation in degree to which their memory performance is modulated by value

Value



High value cues engage the mesolimbic dopaminergic reward circuitry of the brain, including the nucleus accumbens and the ventral tegmental area, which in turns lead to up-regulation of hippocampal encoding processes.

Value Directed Remembering



5 runs

24 trials/run

High values: {10,11,12}
Low values: {1,2,3}

Free recall after each run

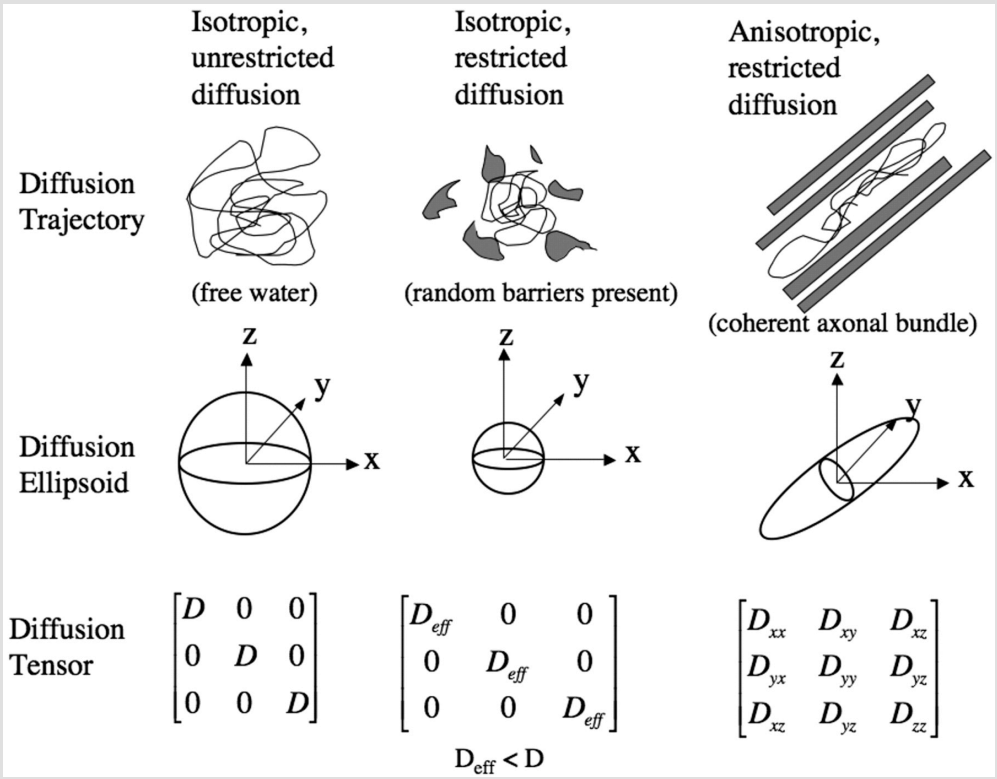
Behavioral Measures

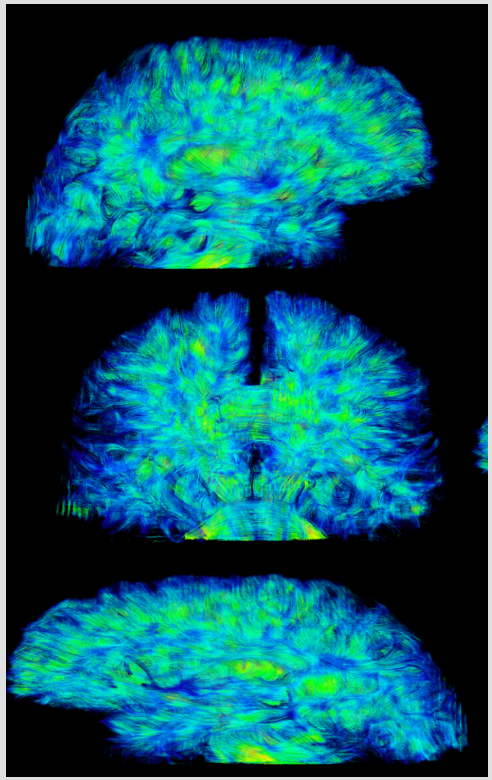
Number of High Value Words Recalled

Number of Low Value Words Recalled

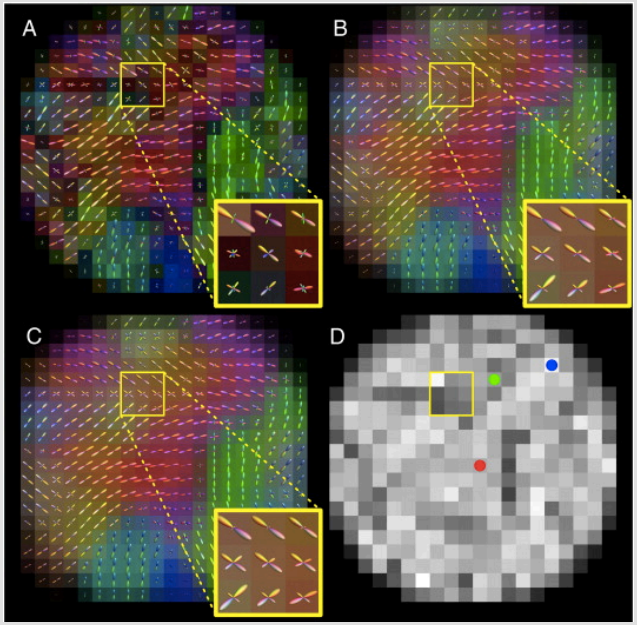
$$\text{Selectivity Index} = \frac{\text{Actual Score} - \text{Chance Score}}{\text{Ideal Score} - \text{Chance Score}}$$

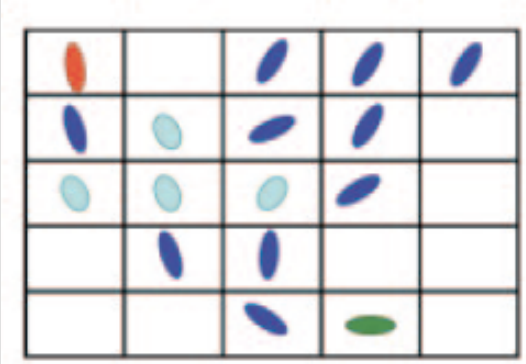
DTI

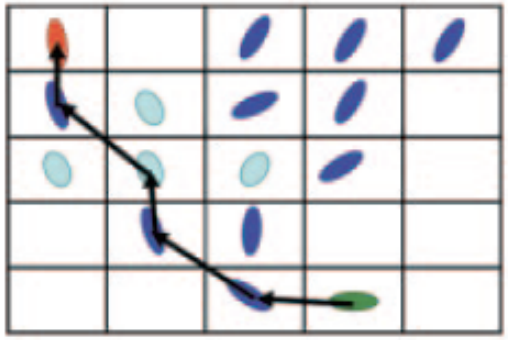

Isotropic, unrestricted diffusion
Isotropic, restricted diffusion
Anisotropic, restricted diffusion
Diffusion Trajectory
(free water)
(random barriers present)
(coherent axonal bundle)
Diffusion Ellipsoid
z
y
x
Diffusion Tensor
$\begin{bmatrix} D & 0 & 0 \\ 0 & D & 0 \\ 0 & 0 & D \end{bmatrix}$
$\begin{bmatrix} D_{eff} & 0 & 0 \\ 0 & D_{eff} & 0 \\ 0 & 0 & D_{eff} \end{bmatrix}$
$\begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{xz} & D_{yz} & D_{zz} \end{bmatrix}$
$D_{eff} < D$



DTI



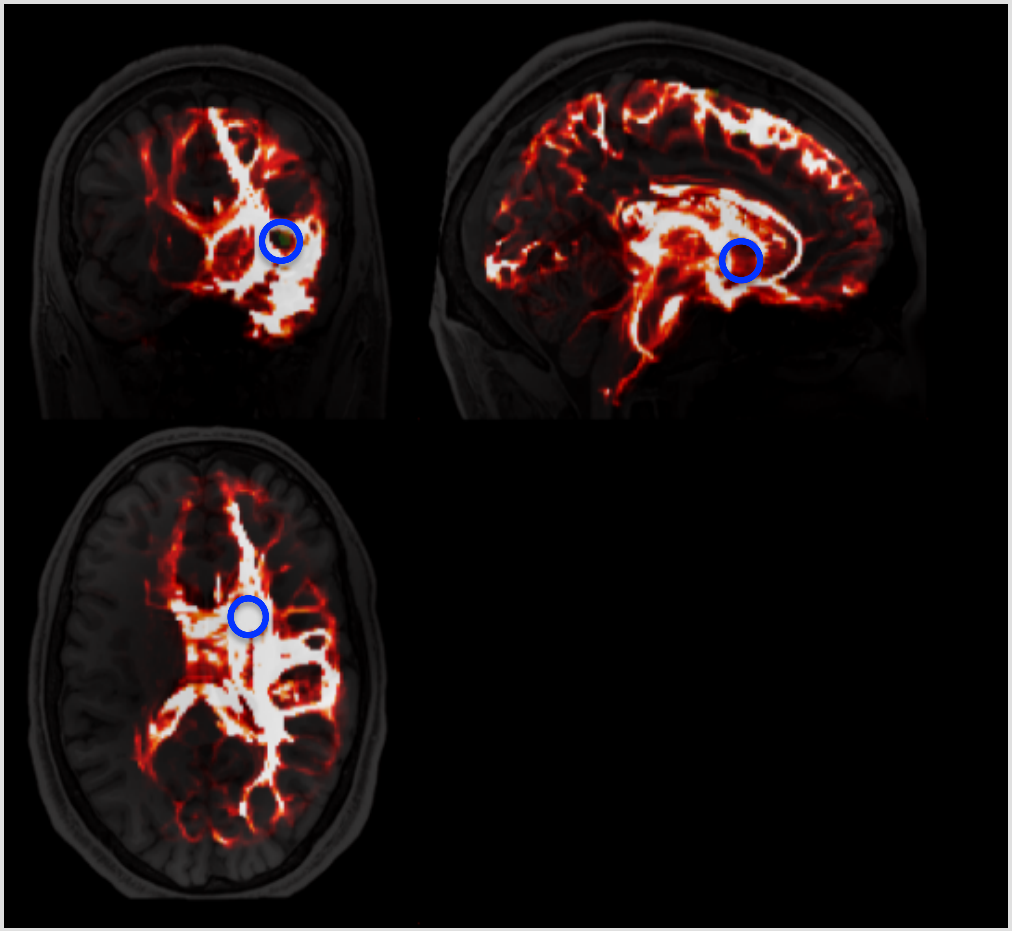




10%		2%	1%	1%
15%	10%	5%	3%	
20%	30%	10%	5%	
	50%	30%		
		90%	99%	

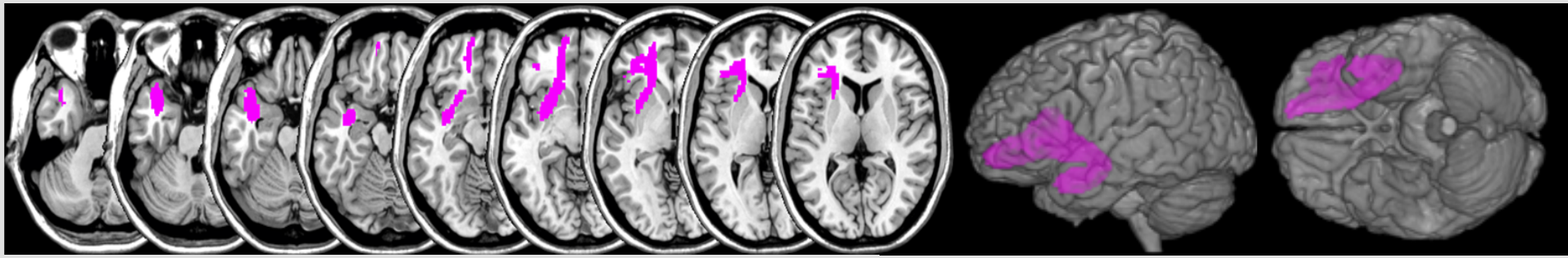
DTI

Whole brain probabilistic tractography maps from a *seed* region (circled in **blue**)



Each voxel's value reflects the *Anatomical Connectivity Index* of that voxel with the *seed ROI*

Analysis



UF ROIs extracted from JHU-White Matter Atlas

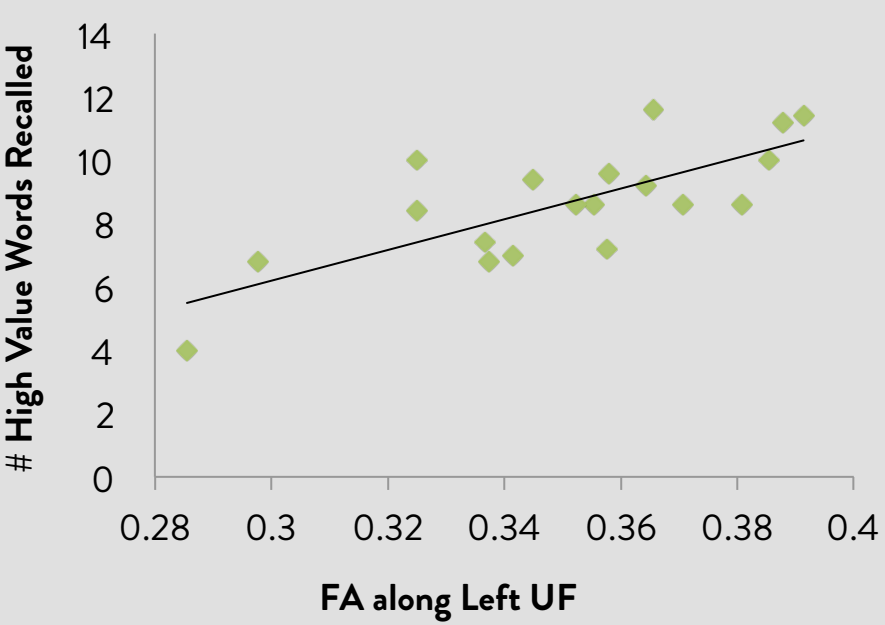
Mean FA of all voxels within the UF calculated for each subject.

Results

Mean FA within the UF is strongly correlated with mean number of high value words reported during free recall, but not with low value words

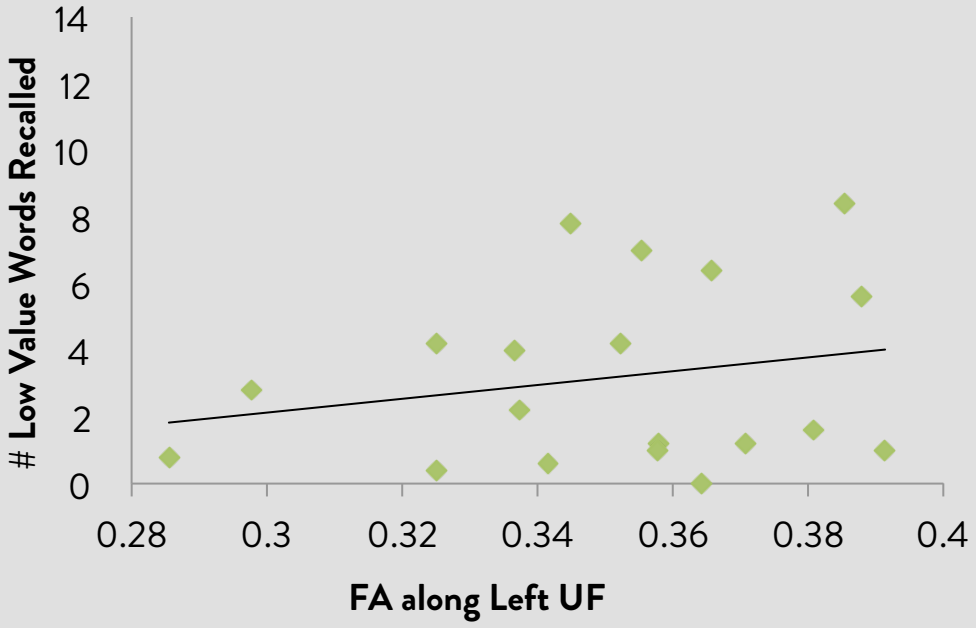
High Value Recall

r = .746, *p* = 0.0001



Low Value Recall

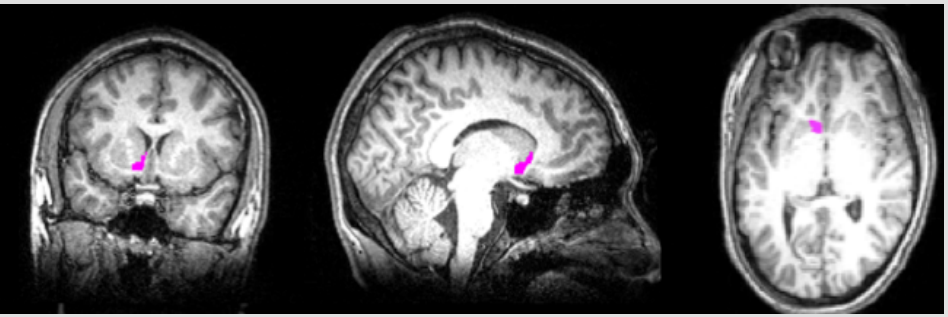
r = .219, *p* = 0.81



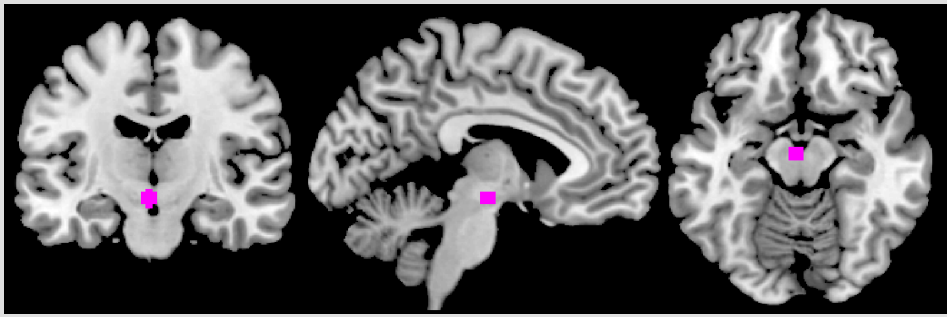
The difference between these two correlations was statistically significant (Z=2.46, p=.006)

Analysis

Left Nucleus Accumbens ROI



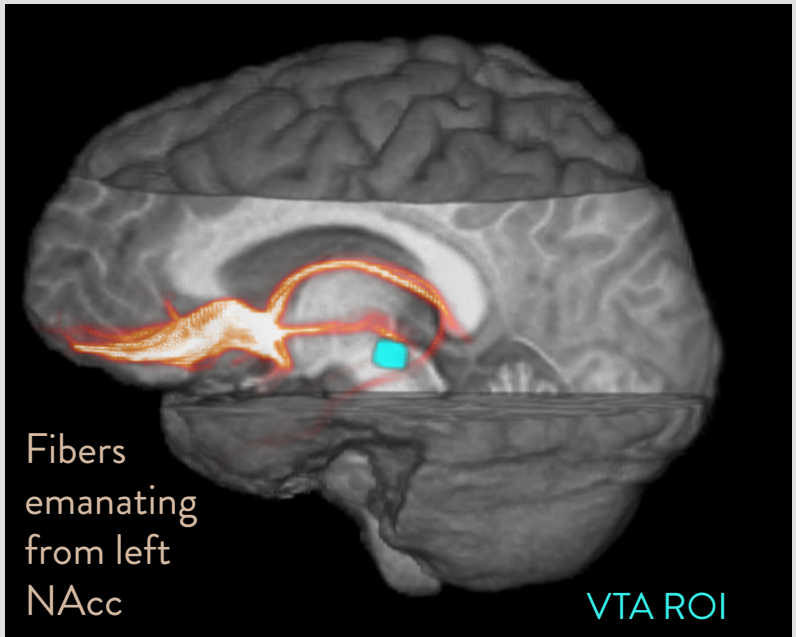
VTA ROI



Left Nucleus Accumbens ROI was identified using FreeSurfer's Automated Segmentation algorithm

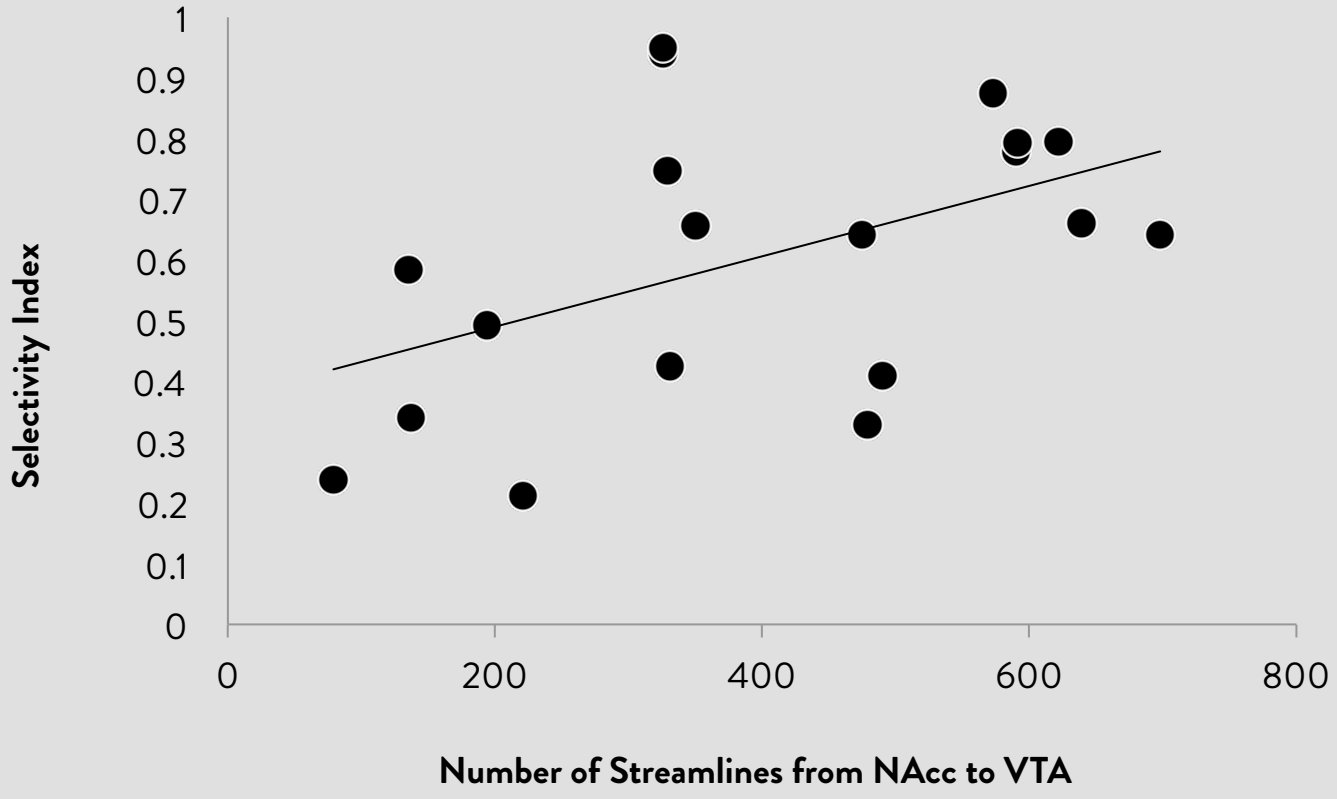
The **VTA** ROI was defined as a 5mm sphere centered around a previously reported coordinate from a monetary incentive delay task [-3,-15,-12]

Probabilistic tractography from L Nacc to VTA to count the number of streamlines across the ROIs.



Results

The number of streamlines (i.e., the **Anatomical Connectivity Index**) from left NAcc to left VTA correlated with **Selectivity Index**.



r = .482, *p*= .018

Interpretations

- "Mean High", emphasizes a subject's ability to remember words with higher associative values .
- FA along the UF plays a critical role in subjects' varying abilities to complete word-comprehension and semantic relation tasks (Harvey, 2013).
- FA along the UF may not only be responsible for semantic encoding, but elaborative, associative encoding in general, especially as it pertain to behaviorally relevant stimuli.
- In high value items, subjects had a greater, self-inflicted demand to use an associative scheme in order to attach the value of the word to the word itself. The successes of such schemas were measured by subjects' ability to recall these words
- **Subjects with a more apt mechanism for associative processes were able to more tightly assign behavioral relevant numbers to specific words.**

Interpretations

- Selectivitiy Index is an index of strategy, as motivated by reward.
- It is reasonable that a richer anatomical basis for reward processing would lead to greater faculties for such tasks.
- Nucleus Accumbens and VTA contribute to the ability to be selective about stimuli by way of enhancing and up regulating temporal encoding processes for behaviorally relevant reward stimuli.
- This dopaminergic reward system would work collaboratively with the Uncinate Fasciculus and it's role in assigning semantic value (using frontal regions) to verbal stimuli and encoding it (using up regulated temporal regions).
- The integrity of both of these systems is crucial for behavioral performance, so much so to the point that deviations from optimal circuitry can lead to degradations in value directed remembering.

Thanks!

Memory recall for high value words correlates with individual differences in white matter pathways associated with reward processing and fronto-temporal communication

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