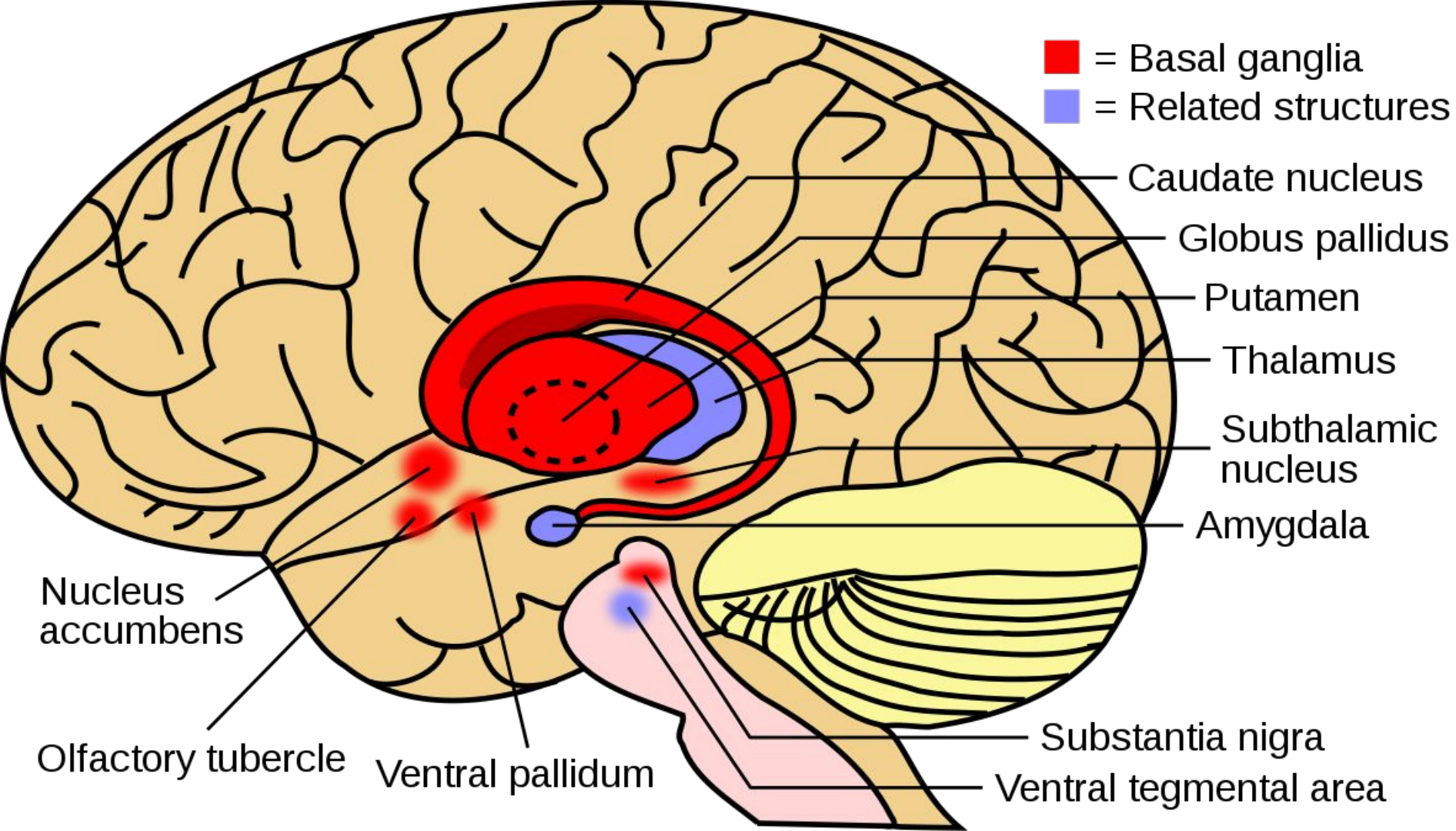


Dopaminergic basis for signaling belief updates, but not surprise, and the link to paranoia

Matthew M. Nour et al.

Background/Introduction

- Dopamine plays a role in processing the meaningful information content of observations.
- No direct evidence for its role in human belief updating
- Meaningful vs meaningless sensory info
- Phasic activity → unexpected and salient environment stimuli
- ‘Counter evidence’ to what’s expected: surprise (non-meaningful)
- To ‘measure’ amount of change from one belief to another → Kullback-Leibler divergence/Bayesian surprise (meaningful)
- Dopaminergic activity: stimulus locked → processes information
 - If compromised then stimulus will be interpreted incorrectly → paranoia, schizophrenia etc.
- Ventral tegmental area and substantia nigra (VTA and SN)



Purpose of Experiment

- Trying to show relationship between encoding meaningful information and dopamine- $\frac{2}{3}$ receptor availability in midbrain
- Correlation \rightarrow not causation
- How we recognize which information is important
- To investigate the basis of dopamine in belief updating

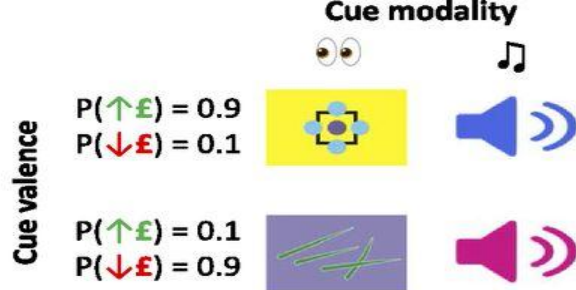
Hypothesis

- Greater striatal dopamine release capacity would be associated with lower ventral striatal neural response during belief updates.
- Inverted-U relationship

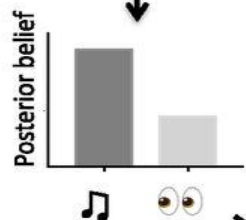
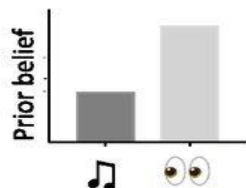
Methods

- Trials done to test people's updating information system in their brain
 - Non-informative vs. informative trials.
 - Bayesian surprise vs. information-theoretic surprise vs. reward prediction
- Question: Will there be or will there not be money?
- Visual vs. auditory cues
- 39 participants
- PET and fMRI scan
 - The more blood flow → the more active
 - PET scan with dopamine- $2/3$ receptor agonist ligand
 - More signal from the PET scan → more inhibition → less activity

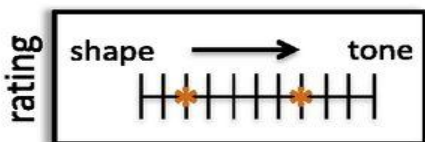
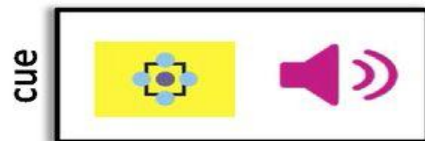
3 sessions of 60 trials
(50% informative, 50% uninformative)



Participant belief



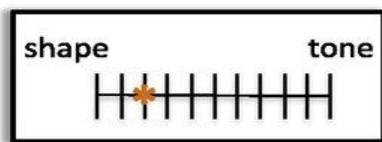
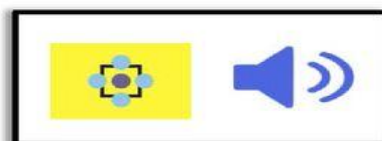
Informative trial



$$I_s > 0$$

$$D_{KL} > 0$$

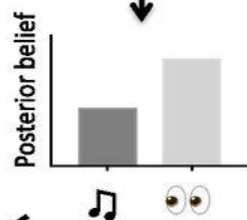
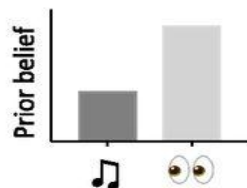
Noninformative trial



$$I_s > 0$$

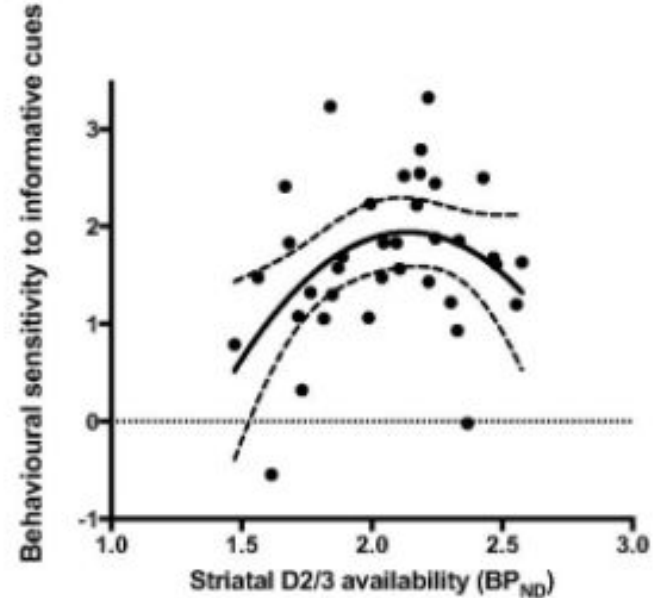
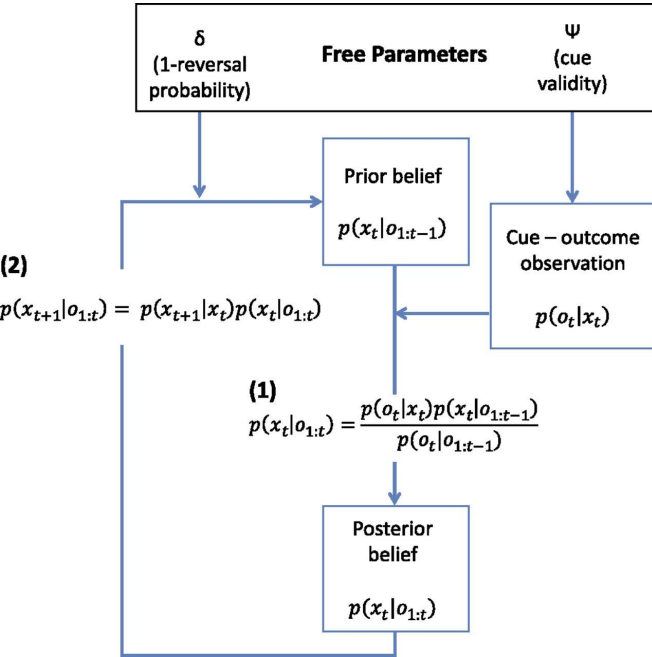
$$D_{KL} = 0$$

Participant belief



Results

- Behavior was closely approximated by Bayesian observer model
- Inverted-U relationship recognized between dopamine levels and cognitive flexibility.
- Poor overall performance → reduced behavioral sensitivity → paranoia

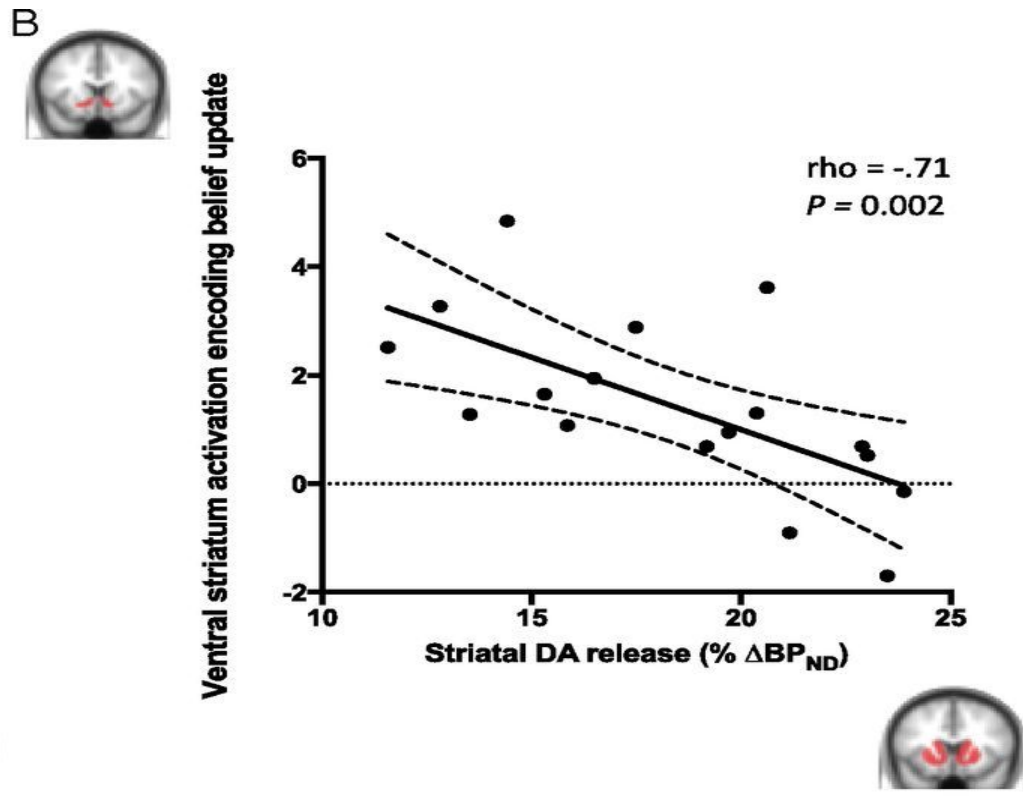
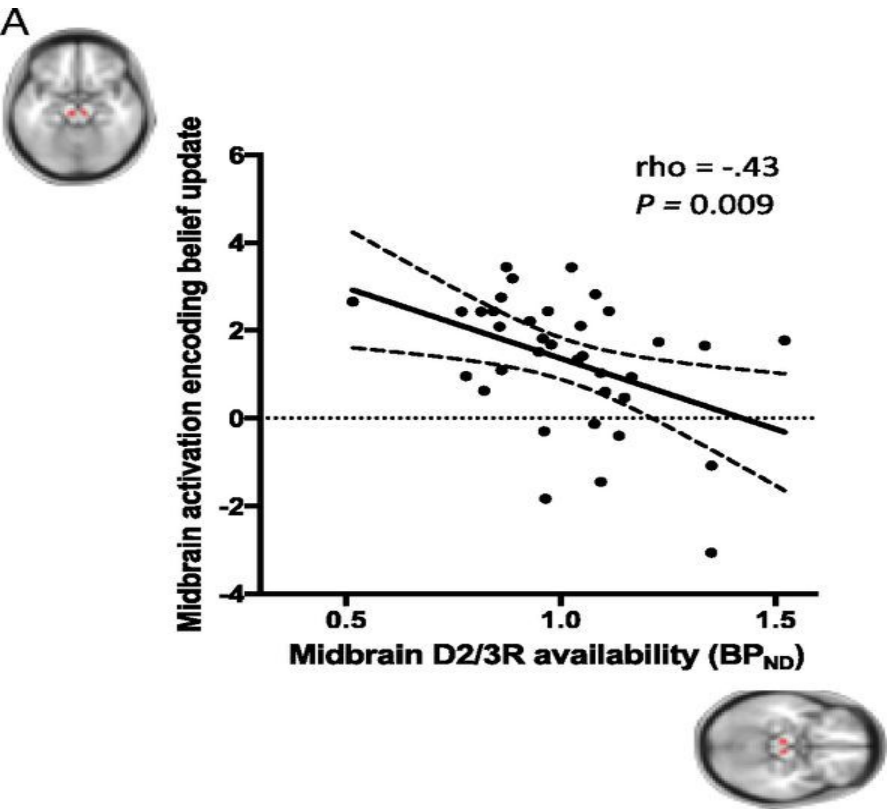


Results

- Paranoia → absolute magnitude of reported belief shifts on meaningless trials
- No link to memory skills
 - Digit span assessment
- Magnitude of belief update proportional to expectations about cue validity

Results

- Location → SN/VTA complex and ventral striatum
- Left ventral striatum and midbrain → link back to negative correlation hypothesis



Discussion/Conclusions/Summary

- In vivo PET scans → inverted U relationship
- fMRI → negatively correlation between D2/3R ventral striatal and behavior sensitivity.
- Bayesian surprise → VTA/SN
- Information-theoretic surprise → frontal areas
- Paranoia

ANY?
QUESTIONS

