Functional neural signal variability during decision making associated with age and dopamine receptor availability

Morgan K. Taylor[1], Kendra L. Seaman[2], David H. Zald[3], Gregory R. Samanez-Larkin[1]

[1]Department of Psychology and Neuroscience, Duke University & Center for Cognitive Neuroscience, Duke University

[2]School of Behavioral and Brain Sciences, University of Texas, Dallas [3]Department of Psychology, Vanderbilt University

Duke MOTIVATED COGNITION & AGING BRAIN LAB

Center for Cognitive Neuroscience DUKE UNIVERSITY

Introduction

Most functional neuroimaging research focuses on differences in mean BOLD activation across conditions. However, accruing evidence suggests that variability of the neural signal can be an important individual difference measure. Several studies have examined adult age differences in variability with mixed results. Some researchers have reported increases in variability with age during task and rest, while others have reported the opposite.

? In decision making tasks, does functional neural signal variability increase or decrease across adulthood?

Although not measuring it directly, fMRI studies of value-based decisions often assume that neural signals are dopamine-related. However, only one previous study has examined associations between fMRI signal variability and PET measures of dopamine.

? Does functional neural signal variability during decision making correlate with dopamine receptor availability across adulthood?

Methods

Discounting Tasks during fMRI

75 participants (22–83 years old) completed three incentive-compatible decision tasks (time, probability, effort).

Whole-brain analyses correlated age with mean squared successive difference (MSSD) of the BOLD signal.

$$\delta^2 = \frac{\sum_{\tau=1}^{n-1} (x_{\tau+1} - x_\tau)^2}{n-1}$$

Time
today, 2 months, 4 months, 6 months

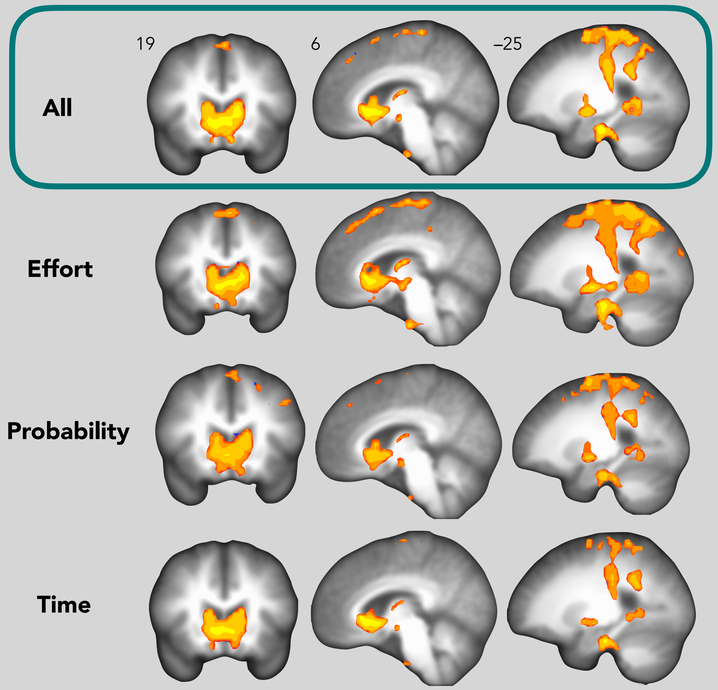
Probability
100%, 75%, 50%, or 25%

Effort
35%, 55%, 75%, or 95% of max. pinky press rate

Results

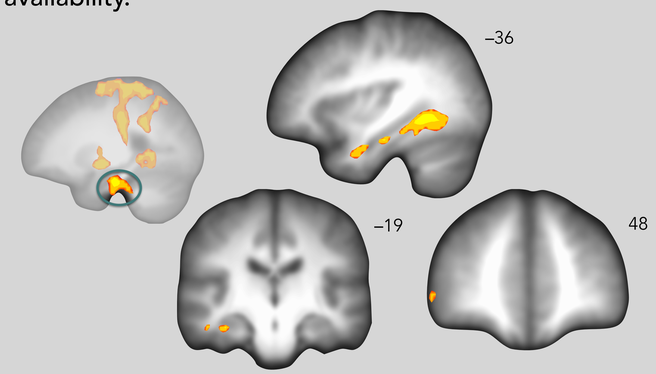
BOLD Variability and Age

Variability ***increased*** with age in bilateral striatum, hippocampus, and parietal cortex ($p < .0001$, 20 voxel cluster threshold).



BOLD Variability and Dopamine Receptor Availability

70 of the same participants also completed a PET scan on a different day assessing D2-like dopamine receptor availability using [18F]fallypride. Using the peak age effects on BOLD variability from the decision tasks (average), whole-brain voxelwise analyses examined the association between BOLD variability and D2-like receptor availability.



Medial temporal lobe BOLD variability was ***positively correlated*** with D2-like dopamine receptor availability in the hippocampus and temporal cortex ($p < .0001$, 20 voxel cluster threshold).

Striatal BOLD variability was uncorrelated with D2-like dopamine receptor availability.

Discussion

These age-related increases in variability are consistent with previous studies of reward-based decision making and spatial working memory, but inconsistent in direction with some other resting state and cognitive task-based effects. Further investigation is needed to determine what (i.e. sample characteristics, tasks, analysis methods) drives differences across studies. We also identified a novel association between BOLD variability during decision making and dopamine D2 receptor availability in the hippocampus and temporal cortex.

Next steps:

- MELODIC ICA
- Analyze resting state data
- Examine associations with decision making performance / preferences

This work is supported by National Institute on Aging grant R01-AG044838 and the Charles Lafitte Foundation