Neural substrates of risky spatial decisions under conditions of perceptual uncertainty

Kevin Jarbo & Timothy D. Verstynen
kjarbo@andrew.cmu.edu
Carnegie Mellon University & Center for the Neural Basis of Cognition

Background

During visually guided sensorimotor decisions, people bias spatial selections away from sources of penalty to maximize expected gain and avoid losses[1]

Cortical[2] and subcortical[3] regions integrate information about spatial uncertainty with cost to bias perceptual judgments

Here, we present preliminary results of behavioral and fMRI analyses to examine how sensory uncertainty and cost interact during risky spatial decisions

Methods & Paradigm

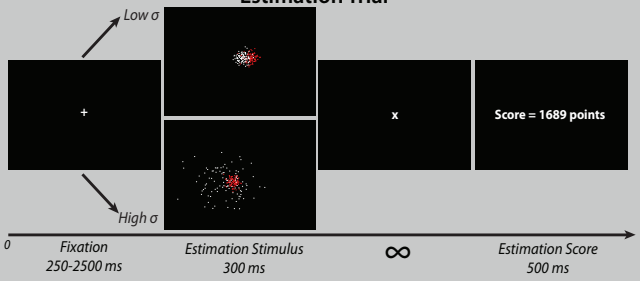
N = 20 adult CMU & Pitt undergrads + grads

2 (Low vs High Variance) x 2 (No Penalty x Penalty) within-subjects

8 (2 per condition) blocks/runs
56 Estimation Trials

Day 1 & 2: behavioral training
Day 3: fMRI

Estimation Trial



Whole Brain MR Acquisition
Siemens 3T Verio w/32-channel head coil
SIBR Center, CMU

T1 176 vols, TR = 2300ms, TE = 1.97ms, 1mm^3

EPI 220 vols, 66 slices, TR = 2000ms, TE = 30ms, MB 3x, 2mm^3

DSI 113d, 66 slices, b-max = 4000s/mm^2, TR = 4110ms, TE = 126ms, MB 3x, 2mm^3

Behavioral Analyses
DV Selection bias in pixels
2-way RM-ANOVA w/in session
1-way ANOVA between sessions

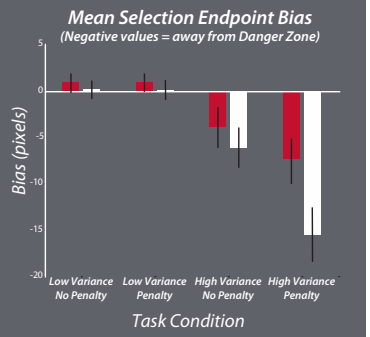
fMRI Design & Analyses
Fast event-related
Single condition per run
Whole brain random effects GLM
ROI-based GLM contrasts

Behavioral Results

Consistent behavior across training and fMRI sessions
Behavioral (**red**), fMRI (**white**)

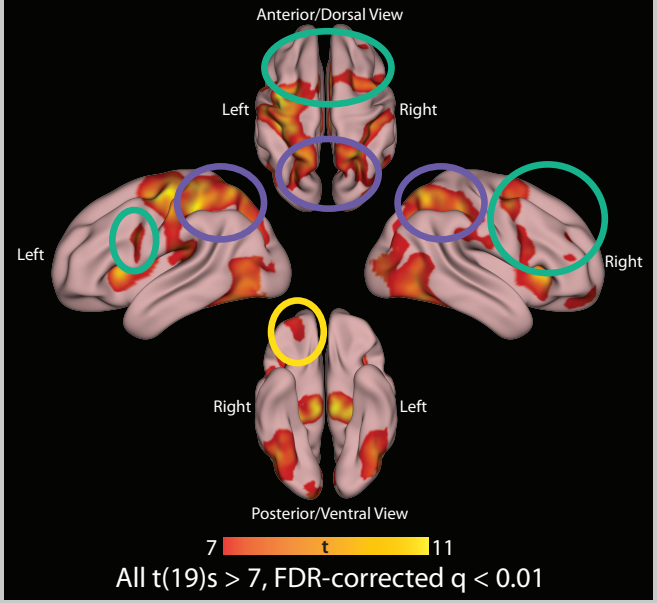
Significant High Variance x Penalty interaction resulted in strongest bias away from Danger Zone
$F(1,19) = 14.50$, $p = 0.001$

Significant main effect of Variance drove bias
$F(1,19) = 19.18$, $p < 0.001$



Cortical fMRI Results

Significant group-level, task-related activation in bilateral **DLPFC** and **PPC**, and right **OFC**

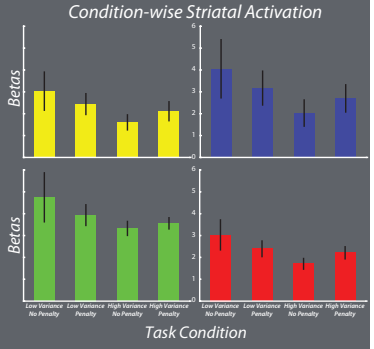


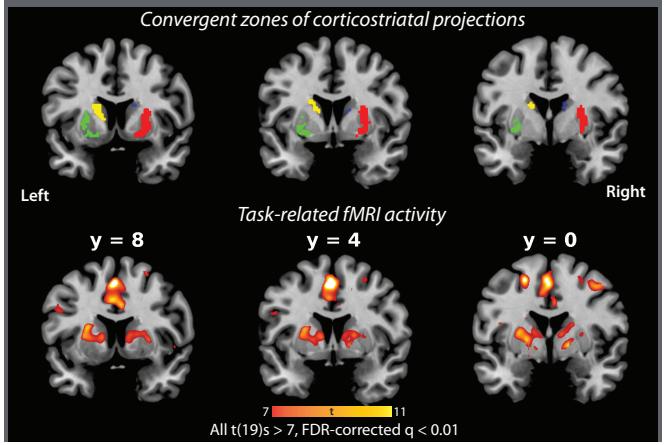
All t(19)s > 7, FDR-corrected q < 0.01

Striatal fMRI Results

DLPFC, OFC, and PPC project to overlapping regions in bilateral striatum[4]

ROI-based analyses using convergence zone seeds showed significant task-related activation, but no significant differences between conditions
All $F(1,19)$s < 3.80, $ps > 0.06$





All t(19)s > 7, FDR-corrected q < 0.01

Conclusion

Our initial results suggest that a distributed corticostriatal network of frontal and parietal regions is engaged during risky spatial decisions

Future Directions

Pattern-based fMRI analyses of task-related connectivity will be conducted to explore condition-specific differences across regions within this convergent corticostriatal network

References
1 Trommershäuser, Landy, & Maloney *TiCS* (2008)
2 Gottlieb & Snyder *Curr Opin Neurobio* (2010)
3 Hsu, Bhatt, Adolphs, Tranel, & Camerer *Science* (2005)
4 Jarbo & Verstynen *J Neurosci* (2015)

Funding Acknowledgement: When these data were collected, author Kevin Jarbo was funded by NIH predoctoral training grant 5T90DA022761-10. This research was supported by the PA Dept. of Health Formula Award SAP4100062201.