

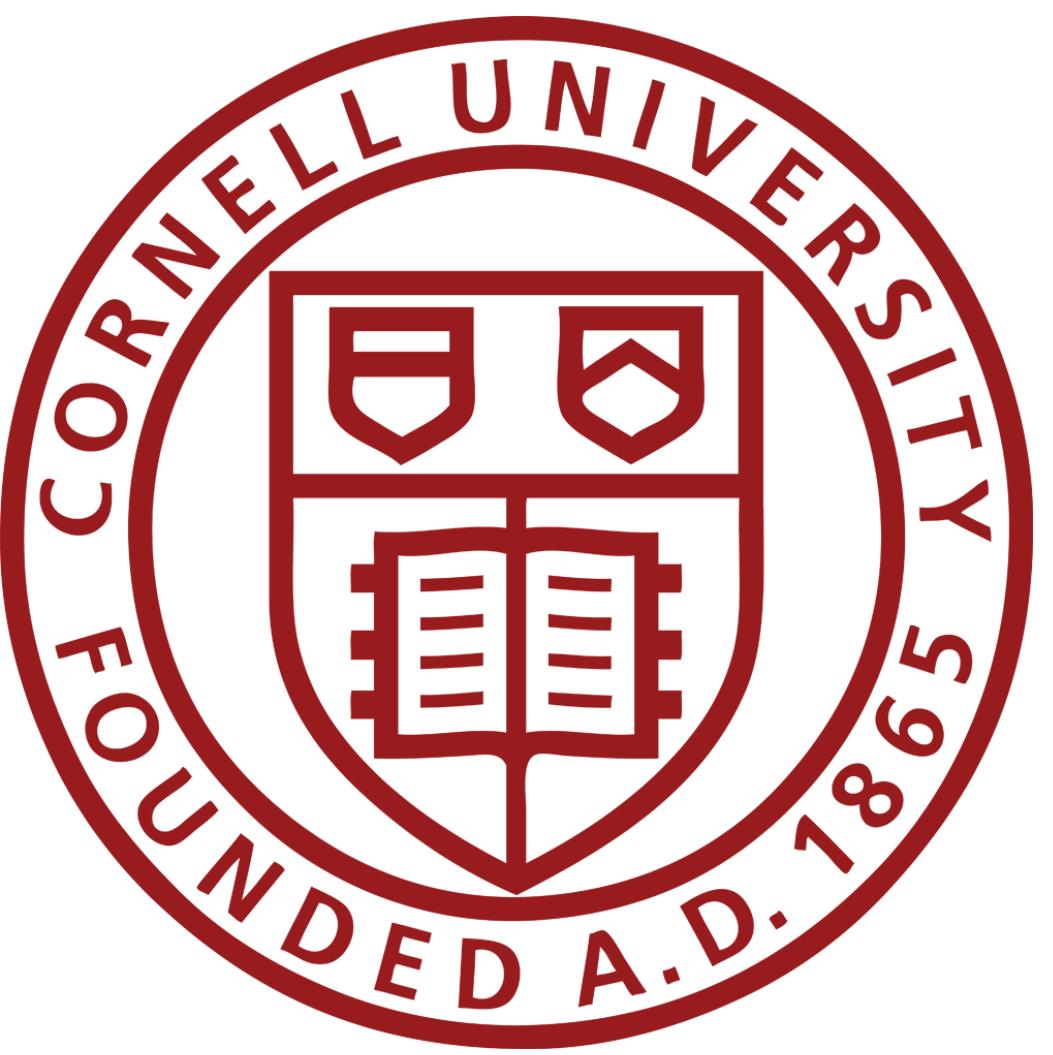


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The Neural Underpinnings of Projection Bias

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INTRODUCTION

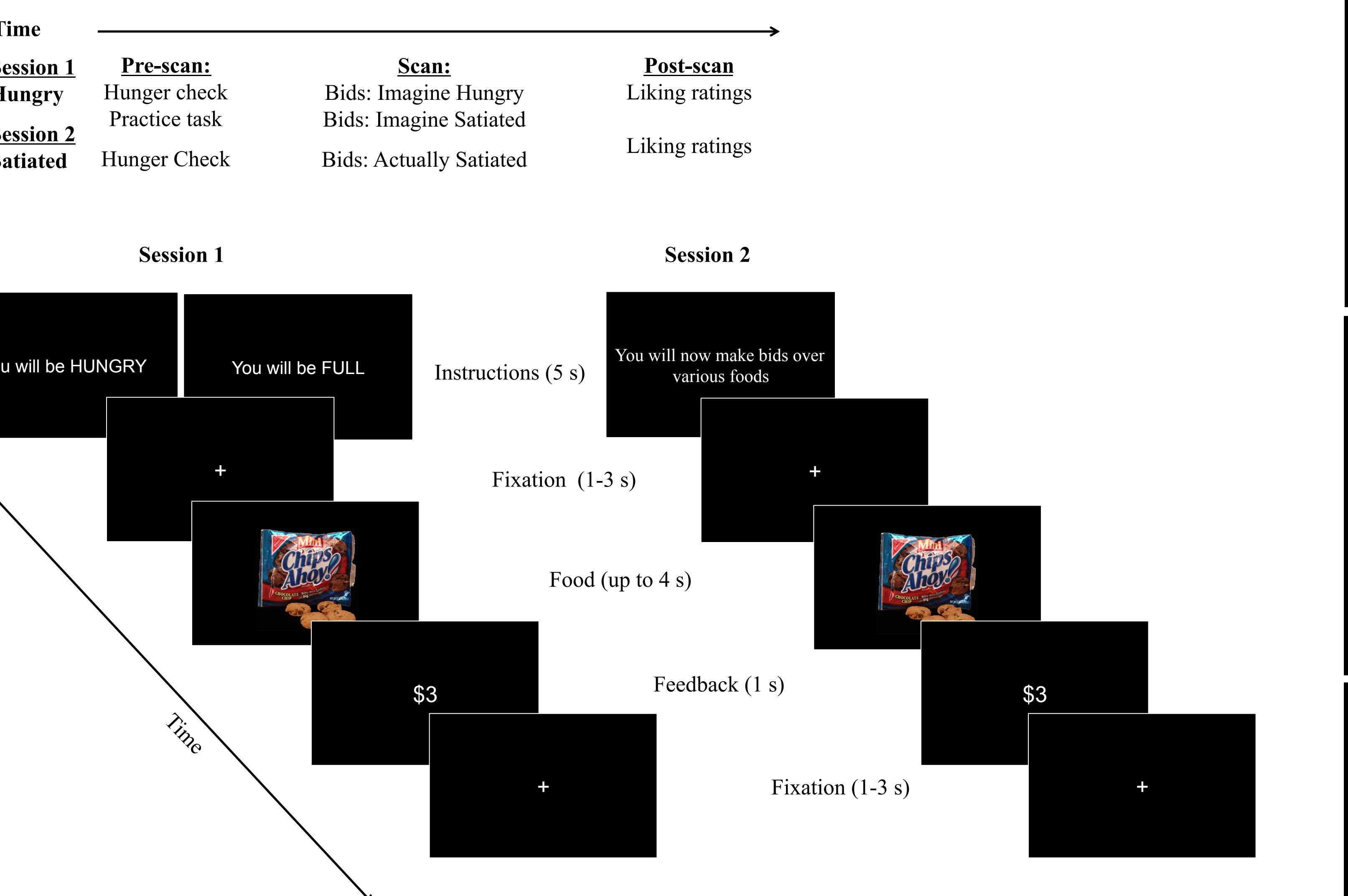
- Projection bias is the tendency to make inaccurate predictions about the future (Loewenstein et al., 2003) and is driven by contextual differences between the present and the future (Gilbert & Wilson, 2007). The cognitive and neural mechanisms that underlie projection bias remain poorly understood.
- We designed a study of future valuation that included a within-subjects hunger manipulation. Participants placed bids on snack food items to gauge present values over two scanning sessions, one where participants were hungry and another when they were satiated. Participants placed bids in three conditions:
 - Imagine Hungry (Session 1):** participants experiencing hunger made bids imagining they would receive the item in a congruent state (i.e., hungry)
 - Imagine Satiated (Session 1):** participants experiencing hunger made bids imagining they would receive the item in an incongruent state (i.e., satiated)
 - Actually Satiated (Session 2):** satiated participants made bids on how much they wanted the item immediately after the scanning session.
- Our bidding task enabled us to:
 - observe brain and behavioral changes to contextual differences in prospection AND
 - observe brain and behavioral changes between prospection and the realization of a prospective episode
- We predicted that imagining an incongruent future state would recruit brain areas associated with executive control due to difficulty and/or novelty (e.g., Roberts et al., 2017) of task.
- We also predicted that behavioral projection bias would be driven by heightened present value in areas related to reward processing.

METHODS

- Participants:** 25 healthy young adults (mean age = 22.5, SD = 2.8, 15 women)
- Bidding task:**
 - Participants viewed a stream of snack items and were asked to bid \$0, \$1, \$2, or \$3 for each item
 - Session 1: Participants came in hungry after fasting for 5 hours and made bids on how much they would want the items in an imagined future state (Imagine Hungry, Imagine Satiated); 6 blocks of 10 trials each were presented for 3 runs.
 - Session 2: Participants came in satiated 30 minutes after eating a full meal and made bids on how much they would want the items immediately after the scan (Actually Satiated); 1 block of 45 trials each presented for 2 runs (90 trials per condition).
- fMRI Acquisition:**
 - Images collected on a GE 3T with a 32-channel head-coil at the Cornell Magnetic Resonance Imaging Facility
 - Multi-echo EPI sequence: TR = 3000ms; TEs = 13.7, 30, 47ms; 83° flip angle; 3mm isotropic voxels
 - fMRI Preprocessing and Analysis:**
 - Neuroimages were preprocessed with ME-ICA (Kundu et al., 2012) and analyzed using event-related GLMs in SPM8.
 - Threshold of p<.001 (uncorrected), k=10

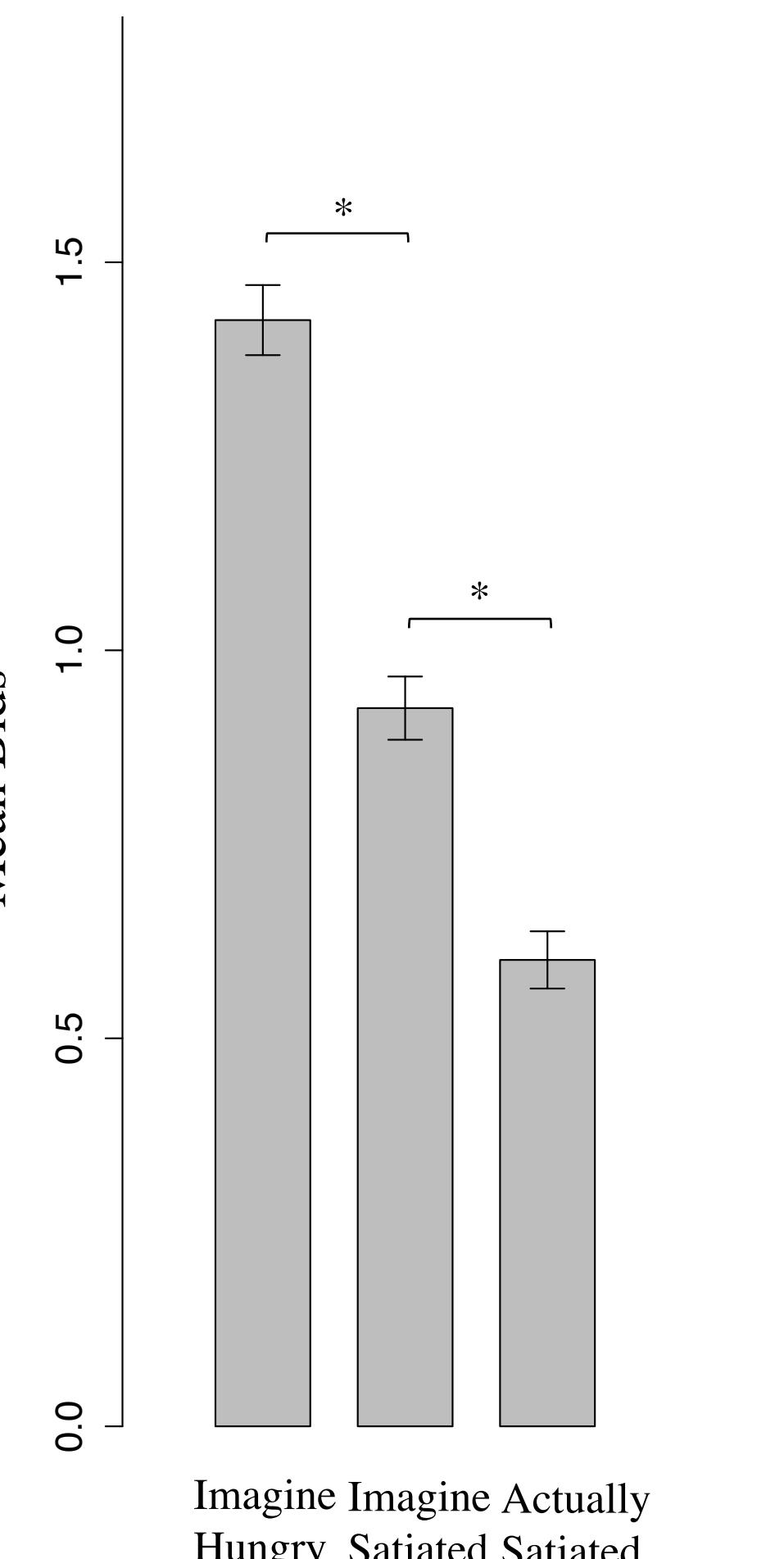
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Task



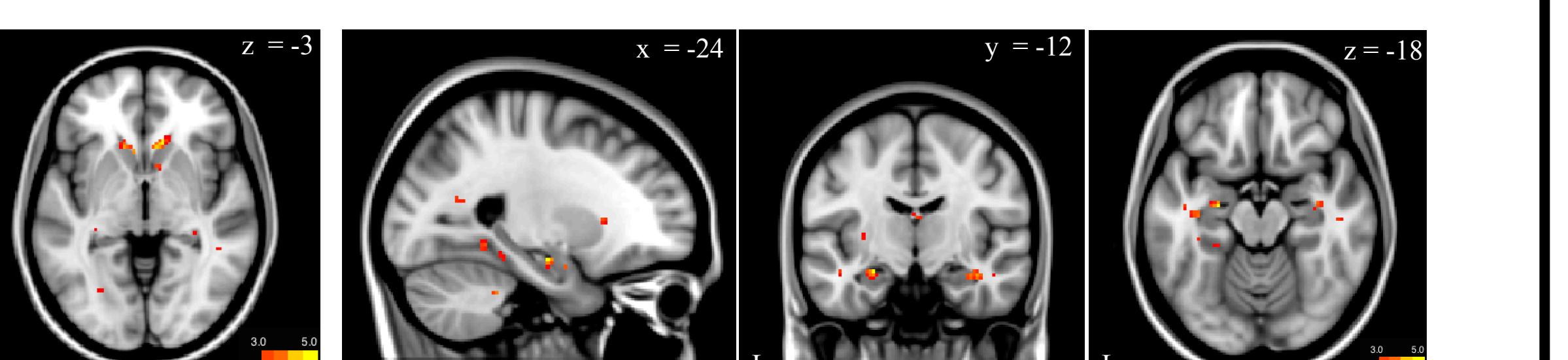
RESULTS

Behavior

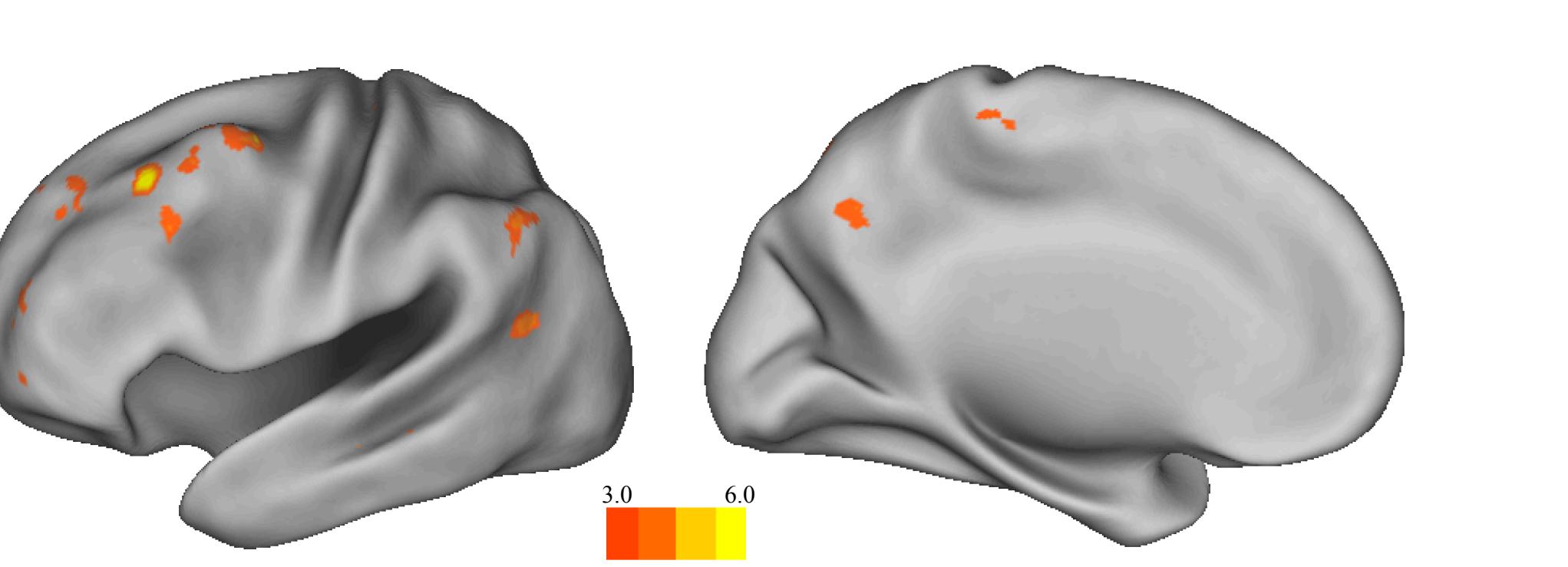


Imaging: Congruence

Imagine Hungry > Imagine Satiated Bids

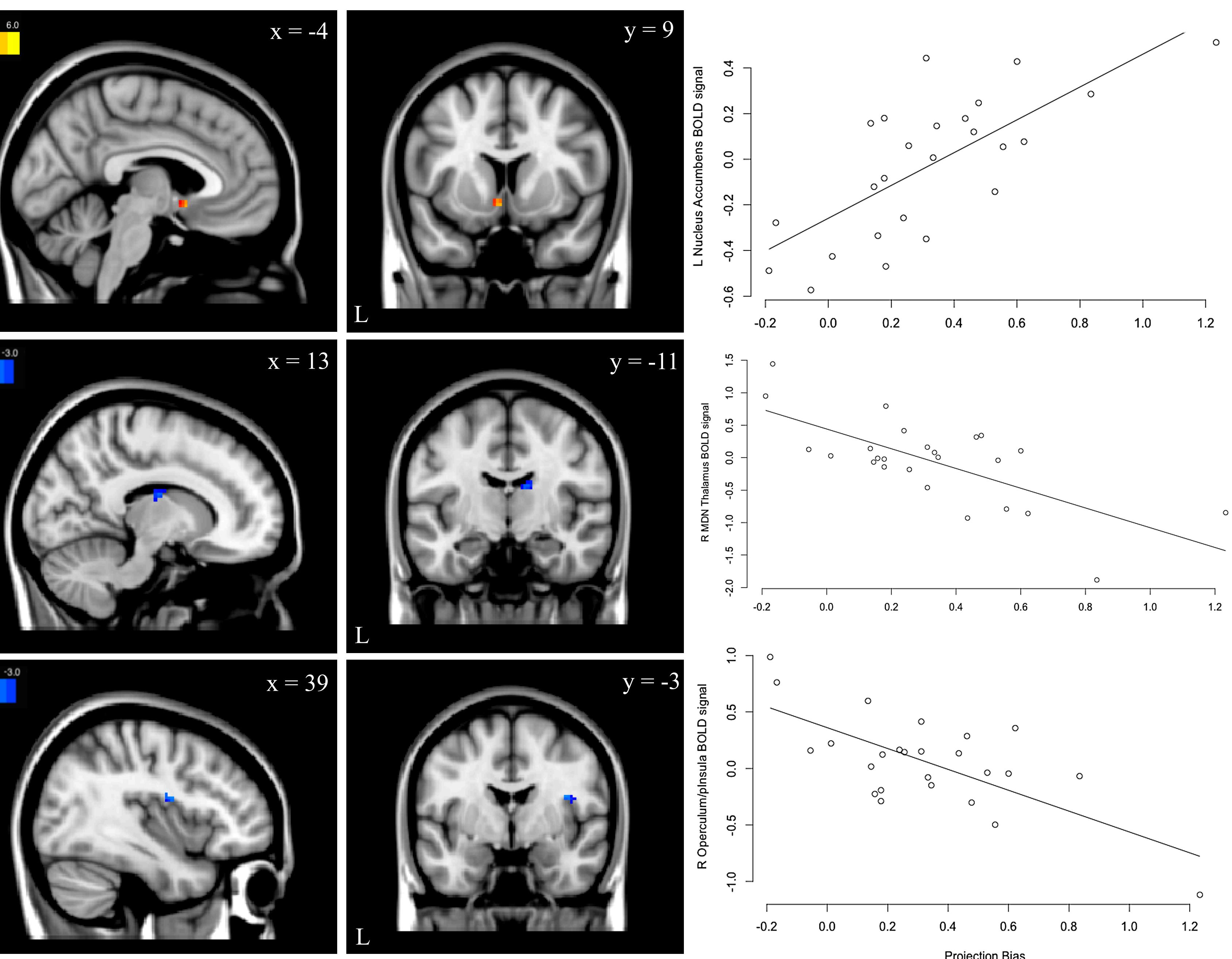


Imagine Satiated > Imagine Hungry



Imaging: Projection Bias

Imagine Satiated > Actually Satiated with Bidding Behavior



CONCLUSIONS

- Participants changed behavior when going from a future state with a similar context to a future state with a different context, but not *as much* as they did when the future was realized → projection bias
- Imagining future episodes with a similar context recruited dorsal striatum, lateral occipital cortex, and hippocampus, areas that have been related to reward contingencies, object recognition, and prospection respectively.
 - Higher present value during future episodes in congruent states may be related to attentional orienting through a visual corticostriatal loop (Anderson, 2017) or vivid prospection (e.g., Geib et al., 2017).
- Imagining future episodes with an altered context recruited lateral frontal and parietal areas related to executive control while imagining future episodes.
- Together, these findings provide evidence that contextual differences in prospection require extra recruitment of resources for flexible future planning (e.g., Spreng et al., 2015).
- Projection bias related to an interplay between reward and control.
 - Larger projection bias related to activity in reward-related nucleus accumbens.
 - Smaller bias related to medial dorsal nucleus of the thalamus, a major prefrontal relay, and opercular cortex/posterior insula, involved in physiological awareness/homeostatic activity (Menon & Uddin, 2010). Connectivity between these areas has been associated with executive control and goal-directed behavior (Mitchell, 2015).