Right hemisphere involvement in updating mental representations

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How Do We Form and Update Models?

We form models of our environment through experience.
- Formed through implicit learning processes.
- Can develop models of space, time, and contingencies.
- These implicit models help guide our behaviour.

What happens when the environment changes?
- We detect a mismatch between expected and actual outcomes.
- This allows models to change in order to optimize goal-directed behaviour; a function termed representational updating.
- As updating occurs, we continue to test our changing model against the environment until the desired goal-state is met.

What Brain Areas Support Updating?

Prior research indicates that patients with right brain damage have difficulty with tasks that require updating mental models:
- Fail to exploit bias in rock paper scissors task (Danckert et al., 2012).
- Difficulty in updating representation of ambiguous figures from shifting perceptual features (Stoettinger et al., Poster 23.535).

We used a rock, paper, scissors (RPS) paradigm modified for fMRI using 12 healthy controls to examine the neural correlates of updating.

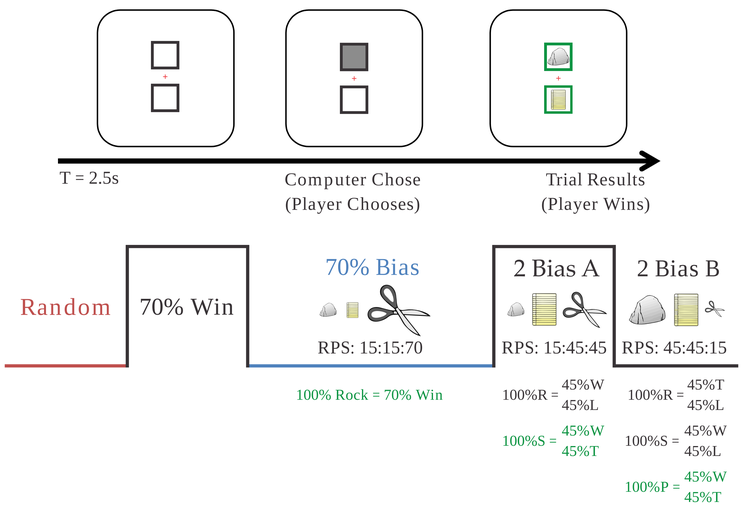

Figure 1. Depicts the RPS procedure and block design protocol. 70% Bias condition resulted in computer playing one option on 70% of the trials. 2 Bias conditions force participant to switch play style to avoid losses. Optimal strategy for each block, and expected wins (W), losses (L), and ties (T) in green.

Participants Detect and Exploit Bias

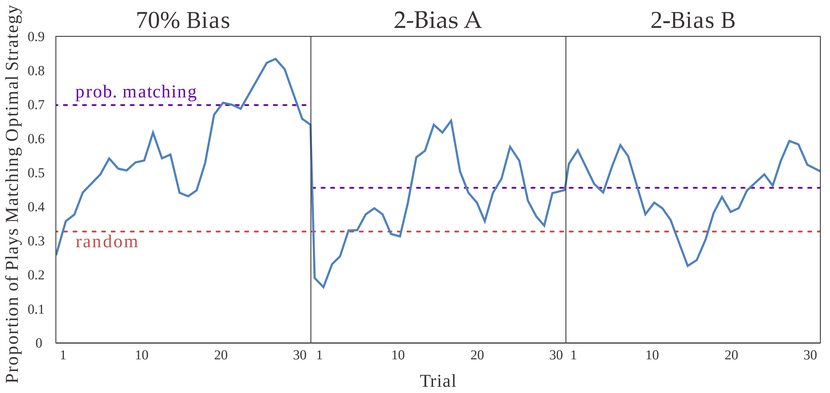

Figure 2. Depicts optimal play exploiting the current computer bias in the labeled block. Red and purple dashed lines indicate threshold for random and probability matching performance, respectively.

Neural Correlates of Updating

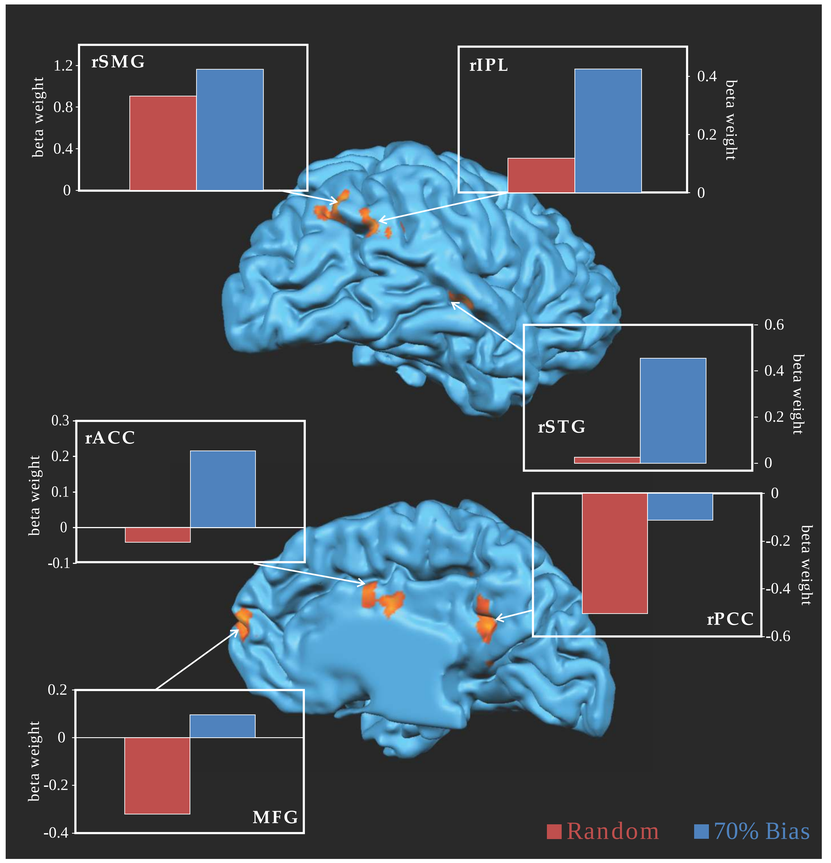

Figure 3. Whole-brain analysis contrast of bias vs. random overlayed on a 3D right hemisphere cortical mesh. Side panels depict extracted beta weights for labeled VOIs for the random vs. biased condition.

Brain-Behaviour Relationships

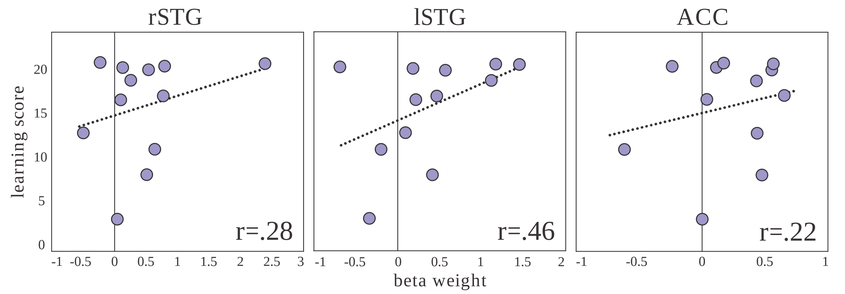

Figure 4. Correlation and scatter plot data depicting associations between the rate of increase in optimal play in the 70% biased condition (learning score) and the corresponding VOI extracted beta weight for each participant. Dotted line indicates linear trend.

Functional Network For Model Updating

1. Imaging results suggest a presence of a network of cortical regions involved in updating mental models that are responsible for, or involve in:
- error detection and competition monitoring (ACC; Carter et al., 1998)
- outcome evaluation and goal attribution (STG; Paulus et al., 2004)
- cognitive control (MFG; Leung et al., 1999)

2. Many of these areas showed modest associations between the extracted beta weights and the rate of behavioural exploitation of the biased computer strategy.

3. Activations in healthy controls, particularly those in the right hemisphere, closely correspond to commonly lesioned areas in the neglect syndrome (e.g., STG); who tend to exhibit performance deficits in similar updating tasks (Danckert et al., 2012).

Additional posters from our lab:

- Filipowicz et al., (Poster #23.310). The influence of task-irrelevant regularities on statistical learning.
- Stoettinger et al (Poster #23.535). Right brain damage failures of perceptual updating in ambiguous figures.

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