Control mechanisms for flexibility in a changing world

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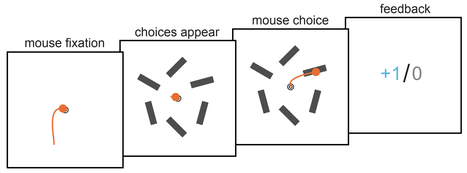
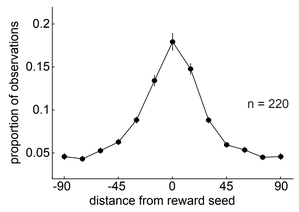
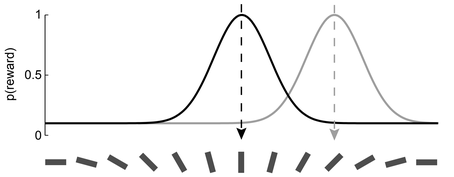
1. How do we search for good options?

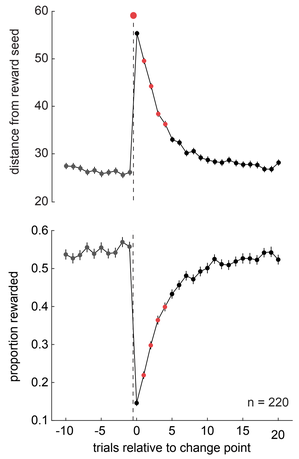
The world is never stable for long. Its successful actors flexibly adjust their behavior when the environment changes. Yet, little is known about how decision-makers change their strategies to adapt to a changing world. How do we sample from different options when the right answer is uncertain? Here, we develop a continuous choice task that allows us to ask what sampling strategies and attentional biases emerge when humans detect a change in their environment and initiate a search for new rewarding options.

2. Task design and baseline performance:

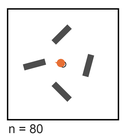




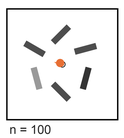




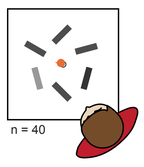
Experiment 1:
Manipulate set size



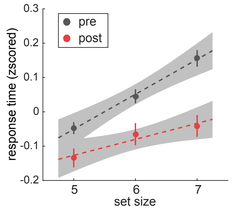
Experiment 2:
Manipulate appearance

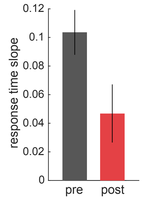


Experiment 3:
Track gaze and pupil



3. Decision-time slopes are flattened after change points.



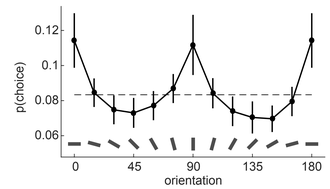


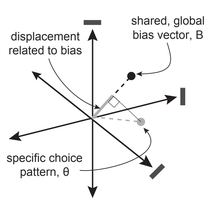
Typically, decisions between more options take longer. But after change points, decisions are less sensitive to set size.

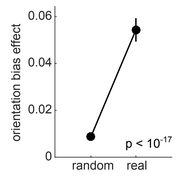
In visual search tasks, flat search slopes suggest bottom-up attentional capture.

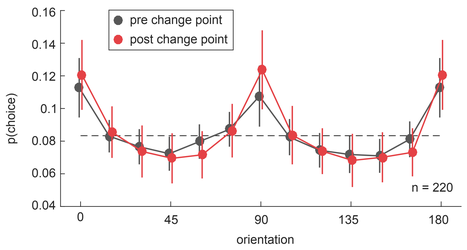
Are decisions also more determined by bottom-up control after change points?

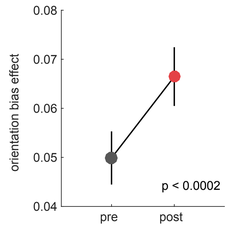
4. Choices are more influenced by shared perceptual biases, but not spatial biases, after change points.



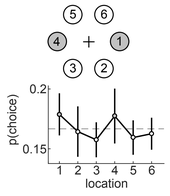


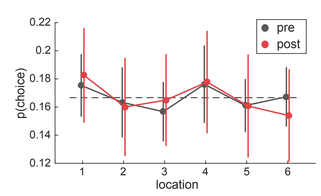


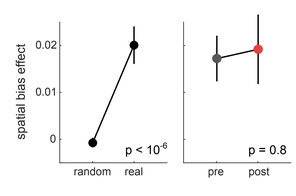




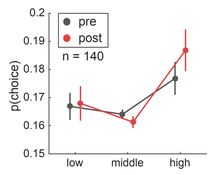
What about other kinds of biases? A spatial bias?

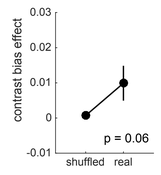


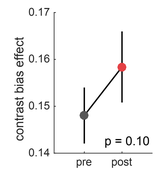


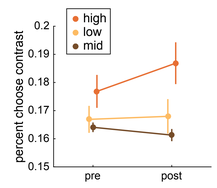


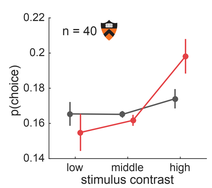
Other perceptual biases?

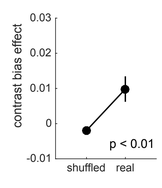


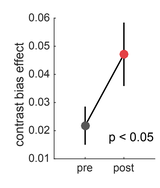


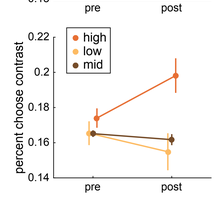




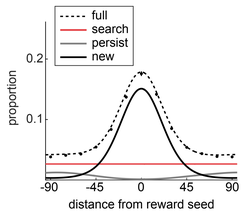


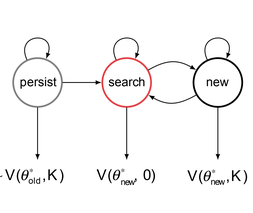


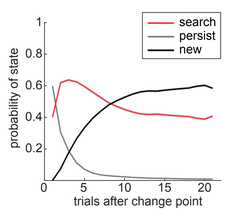




In progress: Trial-by-trial decoding of decision state

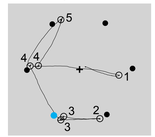


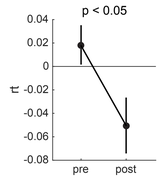


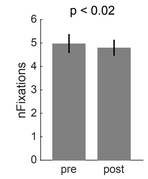


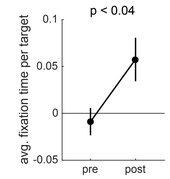
5. Perceptual biases are also selectively enhanced in gaze.

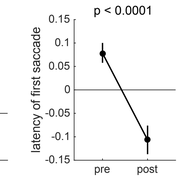
Example trial 1:











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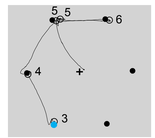

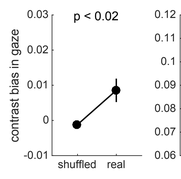

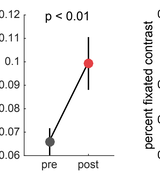

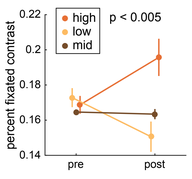

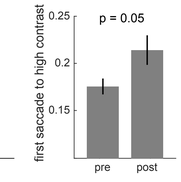

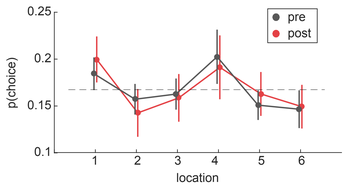

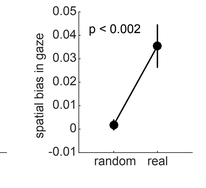

6. Pupil size predicts a tradeoff between accuracy and perceptual bias and is correlated with latent states:

7. Summary:

- After change points, decision times are less sensitive to the number of options.
- Decisions are also more influenced by bottom-up perceptual biases, but not by similarly powerful spatial biases.
- Similar effects are observed in gaze behavior, suggesting that changes in attentional priorities may be related to changes in decisions.
- Pupil size predicts the tradeofff between decision accuracy and bottom-up biases, but does not predict choice precision. Instead, pupil size predicts latent decision-making states.

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