Human adaptation to gradual probability and outcome change

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QUESTION

How do humans adapt their choices to changing conditions in the environment?

INTRODUCTION

- Human decision behavior in dynamic environments is important, ubiquitous and not yet well understood.[4]

- Recent work has found both a *stickiness effect* that hinders adaptation, when initial experiences most impact later choices and inhibit adaptation to change[5,4] and a *recency* effect that facilitates adaptation, when recent experiences most impact later choices and improve adaptation to change.[1,4]

- This work has also found initial evidence of an asymmetry in adaptation for different *directions of change*.[5,4]

- This asymmetry could hinder or facilitate adaptation through stickiness or recency mechanisms: e.g., a changing option that starts off as the preferred option and becomes the less preferred would hinder adaptation through the stickiness effect, but not through a recency effect, and vice versa for a changing option that starts off as less preferred.

- However past work also focused on full feedback conditions[3] (where participants learn the outcome of the chosen and the forgone option), when partial feedback is more ecologically valid[2], and all studies have focused on changing probabilities as the dynamic feature.

- **In two experiments we studied repeated, consequential decisions from experience in an uncertain environment with two separate changing features: outcome probabilities (Experiment 1) or changing outcome values (Experiment 2).**

METHOD

For 100 trials, participants chose between two buttons labeled "A" and "B", receiving outcome feedback based on feedback condition (see Figure 1). Buttons represented one of two uncertain gambles: the **stationary** option or the **non-stationary** option.

For all conditions in both experiments, the stationary option was a gamble {500 points, 50%; 0 points, 50%} probability for all 100 trials. In Constant conditions, the non-stationary option matched it.

In both experiments, participants were randomly assigned to a 3 (*Direction of Change:* Increasing, Decreasing, Constant) X 2 (*Feedback:* Partial, Full) between-subjects experimental condition.

METHOD

Experiment 1: 600 Amazon Mechnical Turk (AMT) workers faced a non-stationary gamble {500 pts, P%; 0 pts, 1-P%} where P (the high outcome probability) depends on direction of change condition and trial number (see Figure 2).

Partial Feedback

Trial:	A	B
1:	500	
2:		500
3:	0	
4:	500	
5:		0
...		

Full Feedback

Trial:	A	B
1:	500	0
2:	0	500
3:	0	0
4:	500	500
5:	500	0
...		

Figure 1. *Sample trials with Partial (left) or Full Feedback about the outcomes of the two options presented to participants. Partial Feedback provided outcomes only for the chosen option.*

Experiment 2: 603 AMT workers faced a non-stationary gamble {H pts, 50%; 0 pts, 50%}, where H (the high outcome value) depended on direction of change condition and trial number (see Figure 2).
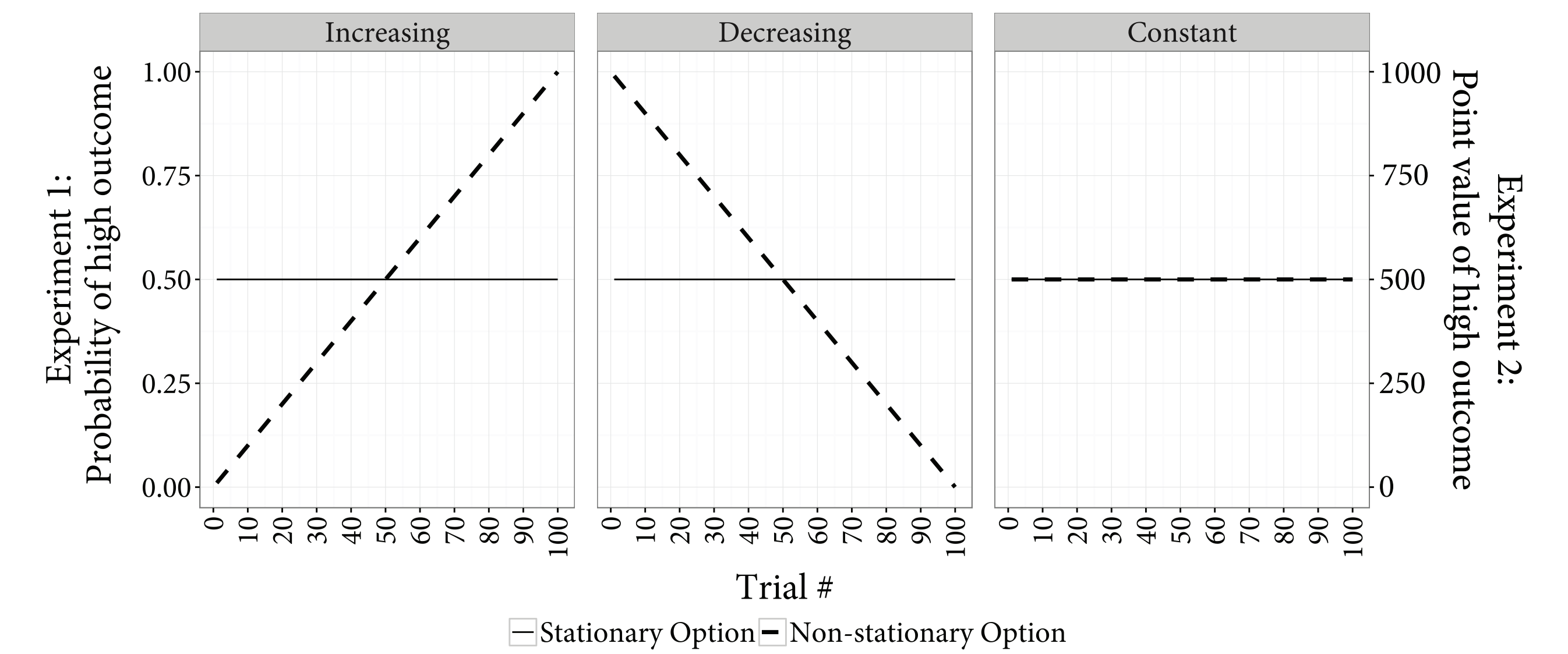
Figure 2. *Probability of receiving the high outcome (Experiment 1, left side) and value of the high outcome (Experiment 2, right side) for the non-stationary option as a functional of current trial and Direction of Change.*
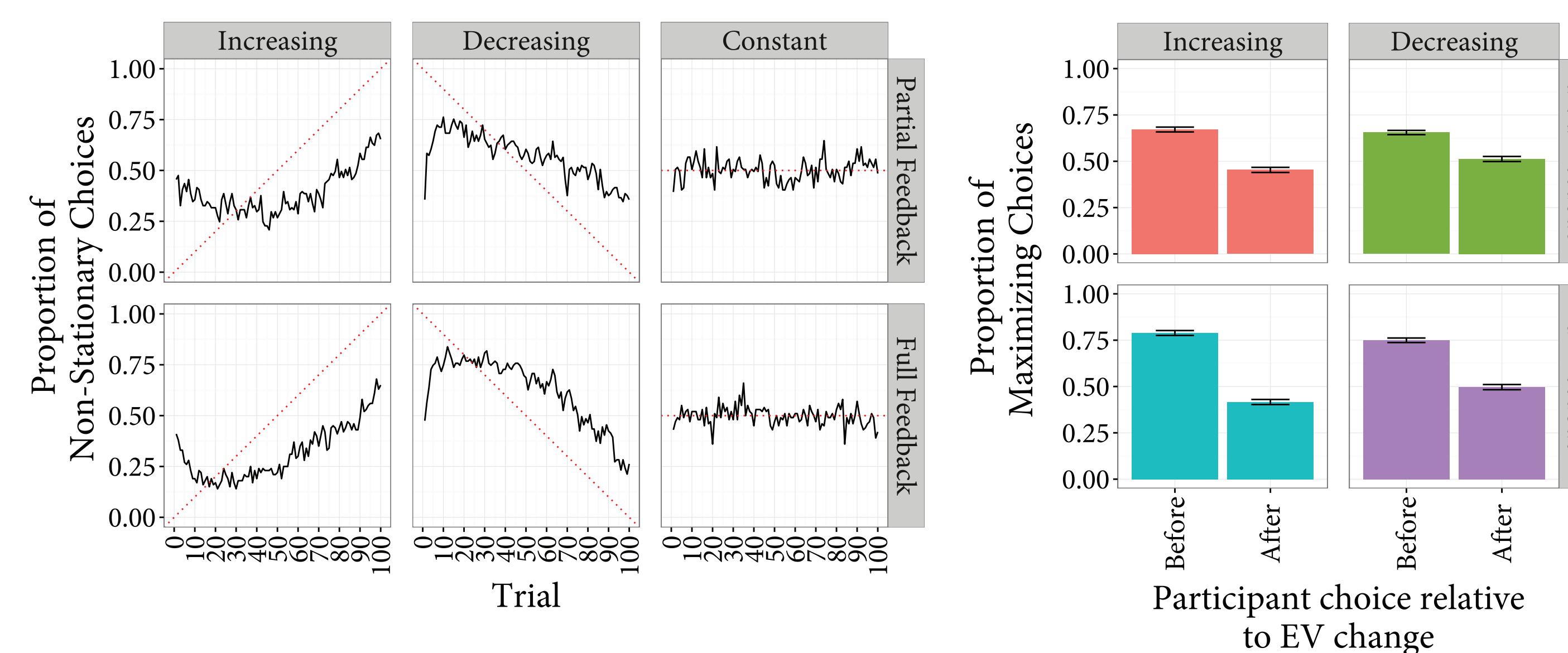
RESULTS

Figure 3. *Choice proportions in Experiment 1, changing outcome probabilities. (Left) Proportion of non-stationary choices across participants over 100 trials, by Direction of Change and Feedback conditions. (Right) Proportion of maximizing choices across participants Before and After the switch in option relative expected values, by Direction of Change and Feedback conditions.*
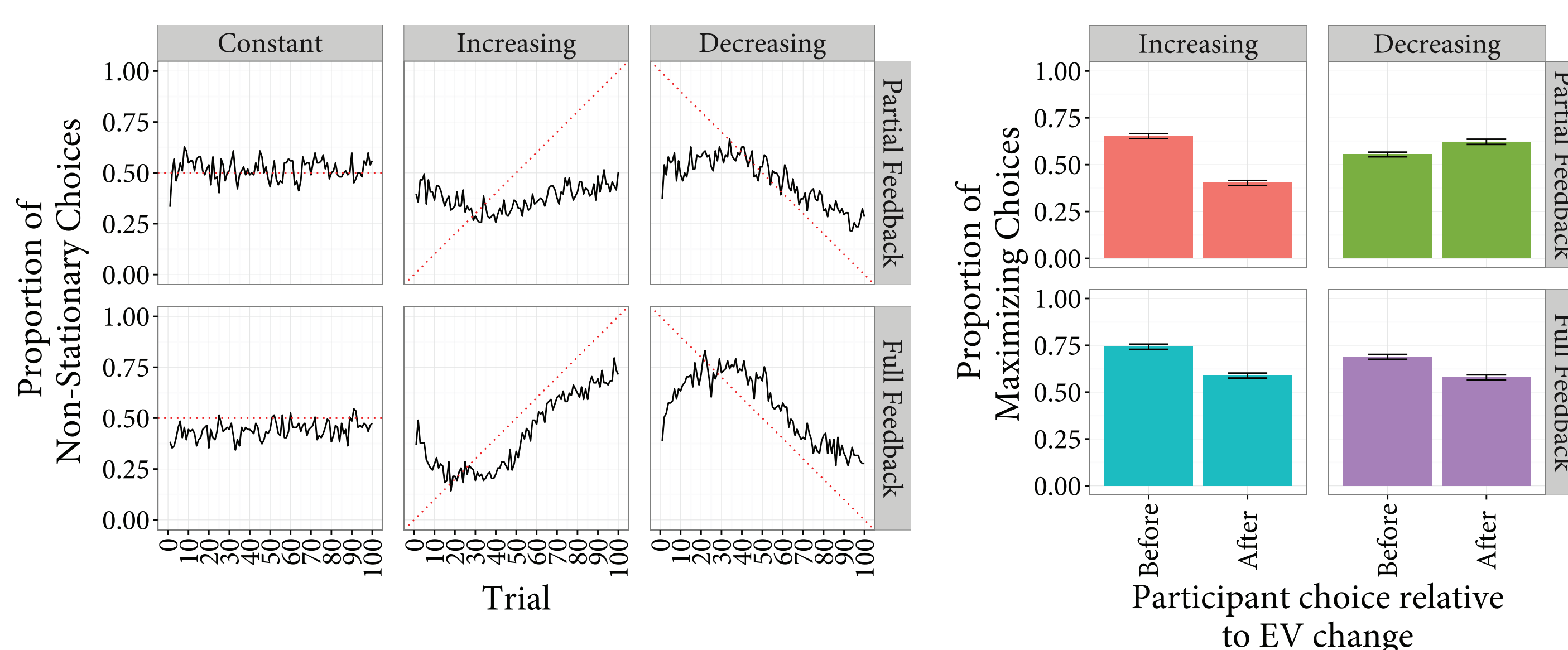
Figure 4. *Choice proportions in Experiment 2, changing outcome values. (Left) Proportion of non-stationary choices across participants over 100 trials, by Direction of Change and Feedback conditions. (Right) Proportion of maximizing choices across participants Before and After the switch in option relative expected values, by Direction of Change and Feedback conditions.*

- Experimental condition and Before/After indicators regressed on per trial maximizing choices with mixed-effects logistic regression, (random intercepts for participant).
- Direction of change asymmetry in Experiment 1, higher log-odds of choosing maximizing option in Decreasing than Increasing conditions, for both Feedback conditions.
- Direction of change asymmetry in Experiment 2 for Partial Feedback conditions, again, higher log-odds of choosing maximizing option in Decreasing than Increasing conditions, but no significant difference in Full Feedback conditions.

DISCUSSION

- **Asymmetrical impact of direction of change on successful adaptation existed, regardless of feedback, in Experiment 1 (changing probabilities): harder to adapt to choosing the option that started out with low probability worse and became better, even with information about the forgone option.**
- **Asymmetrical impact of direction of change only for partial feedback conditions in Experiment 2 (changing outcomes).**
- **Type of information available about a changing environment (direct/first-order observation of a change, e.g., changing outcome values, or second-order observation, e.g., changing probabilities) is just as important as spectrum of available information (partial versus full feedback) in facilitating or hindering adaptation to change.**

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