A Time-Series Saccades Analysis of the Attraction and Compromise Effects Based on the Final Decision in Multi-Alternative Decision Making

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Introduction

Two much-studied findings regarding context-dependent choice effects, the attraction and compromise effects, warrant specific attention since they constitute violations of axioms fundamental to rational choice. The present study addresses these effects collectively because of their important shared commonalities. These effects occur when a third alternative (decoy) is added to a two-alternative choice set. This study examines the effects in a two-attribute form (see Figure 1). The alternatives, namely the target and the competitor, constitute the core set, and choosing one or the other requires a trade-off.

When the decoy is added to this core set, if it is inferior to the target on all attributes, the choice probability of the target should increase relative to that of the competitor. This is called the attraction effect. When the decoy is set to an extreme, such that the target's position becomes intermediate between the decoy and the competitor, the target should be chosen most often. This is called the compromise effect.

To further examine the occurrence mechanism of the two context effects concurrently, we reanalyzed the information search and comparison patterns (saccades) of participants' eye-tracking data in detail, distinguished by their final decisions (target or competitor).

Method

Participants

Sixty-four university undergraduates participated in this experiment.

Design

The basic design variables were (a) the type of the third alternative (corresponding to the attraction or compromise effect), which was manipulated between subjects and (b) the type of the alternative (target, competitor, or decoy). The participants were randomly assigned to the between-subjects conditions.

Materials

We used 10 choice sets from 20 sets developed by Tsuzuki & Busemeyer (2012). Each set contained alternatives from a single type of consumer product and consisted of two core alternatives (the target and the competitor) and a decoy that varied along two attributes (e.g., quality, functional capability, design, or price; see Figure 1).

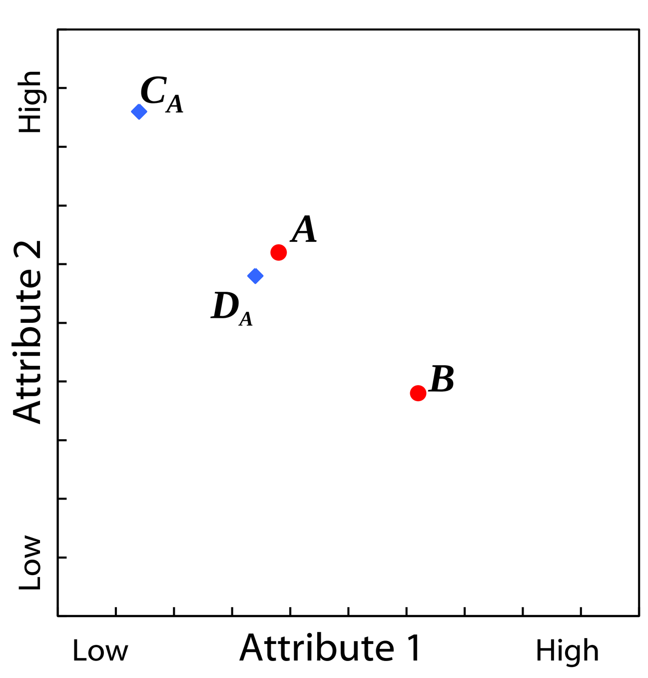

Figure 1. The letters *D* and *C* stand for the decoys for the attraction and compromise effect, respectively.

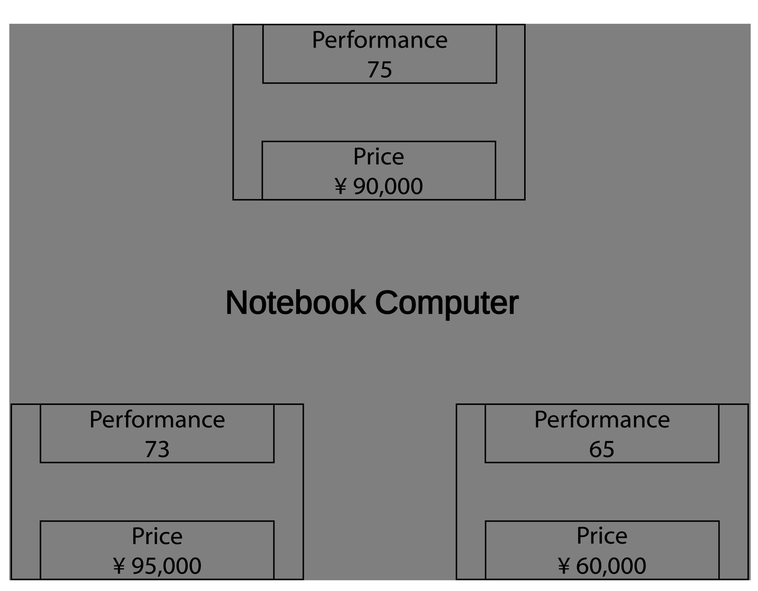

Figure 2. An example of stimuli (the attraction effect condition: the decoy, target, and competitor).

Apparatus

Stimuli were presented on a 23-inch LCD monitor (MITSUBISHI RDT234WLM-D, 200 Hz refresh rate). The experiment was controlled using TobiiStudio Professional. Eye movements were monitored and recorded using an apparatus that operated via the corneal reflex method (Tobii eye-tracker X120). The spatiotemporal resolution was 1 arc min at a sampling rate of 120 Hz. Both eyes were tracked while the participant viewed the stimuli binocularly. A chin and forehead rest maintained the participant's viewing position and distance. The eye movement velocity threshold was 30 degree/s. The I-VT filter in TobiiStudio Professional was used to filter out fixations from the raw eye tracking data.

Procedure

Participants were informed that they would be presented with 10 sets of stimuli comprising three alternatives (the target, the competitor, and the decoy) and that they would have to choose their preferred item within each set. Each choice set was represented by three alternatives, and each alternative was defined along two different dimensions, as shown in Figures 1 and 2.

The arrangement of the alternatives and dimensions on the screen was quasi-randomized in each trial. After presenting the fixation point for 1,000 ms at the center of the screen, we presented the stimulus sets, which remained on the screen until the preference choice was made. During this period, the eye movements made by the participant while choosing from the three alternatives were recorded.

Results

Choice Proportion in the Three-Choice Session

In the attraction effect condition, the mean choice proportions (and *SD*s) of the target, competitor, and decoy were 67.19 (16.31), 29.06 (15.73), 3.75 (4.92), respectively. An ANOVA revealed that the main effect of the type of alternative was significant ($F(2, 62) = 121.38$, $p < .001$, $\eta_p^2 = .80$). Multiple comparisons (Bonferroni-corrected) revealed that the proportion of trials the target was chosen was significantly higher than the proportion for the competitor and decoy ($ps < .01$), confirming a significant attraction effect.

In the compromise effect condition, the mean choice proportions (and *SD*s) of the target, competitor, and decoy were 54.06 (17.01), 30.63 (14.13), 15.31(11.07), respectively. An ANOVA revealed that the main effect of the type of alternative was significant ($F(2, 62) = 39.87$, $p < .001$, $\eta_p^2 = .56$). Multiple comparisons (Bonferroni-corrected) revealed that the proportion of trials the target was chosen was significantly higher than the proportion for the competitor and decoy ($ps < .01$), confirming a significant compromise effect.

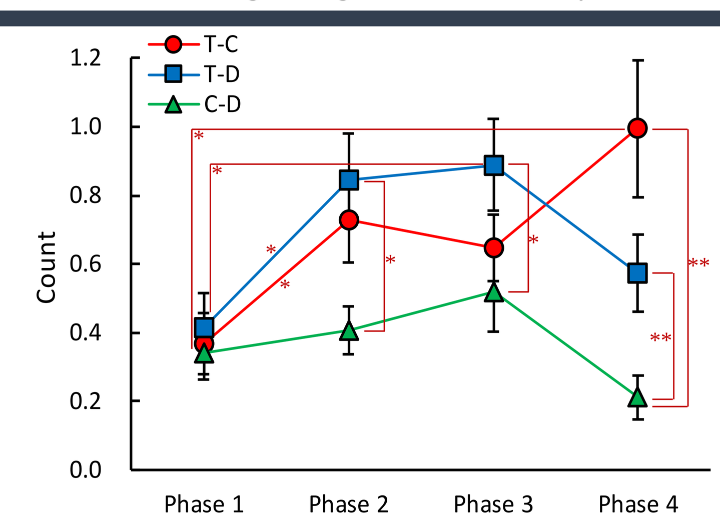

Figure 3. Number of attribute-wise saccades in the **attraction effect** condition (**target** chosen).

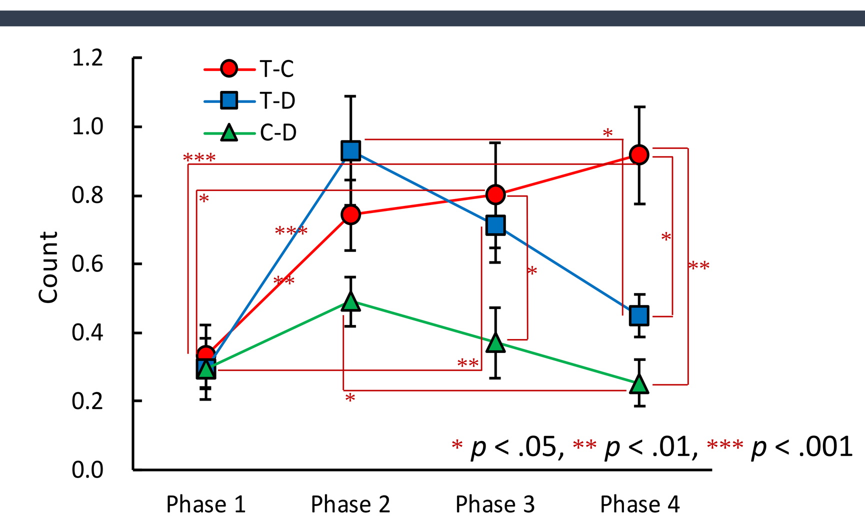

Figure 4. Number of attribute-wise saccades in the **attraction effect** condition (**competitor** chosen).

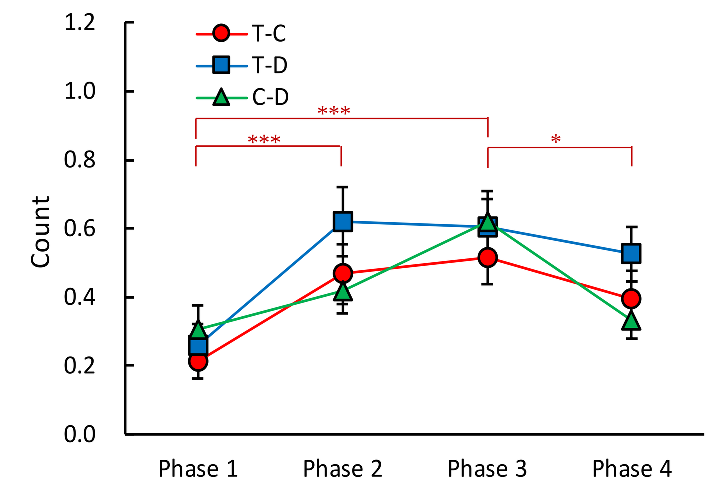

Figure 5. Number of attribute-wise saccades in the **compromise effect** condition (**target** chosen).

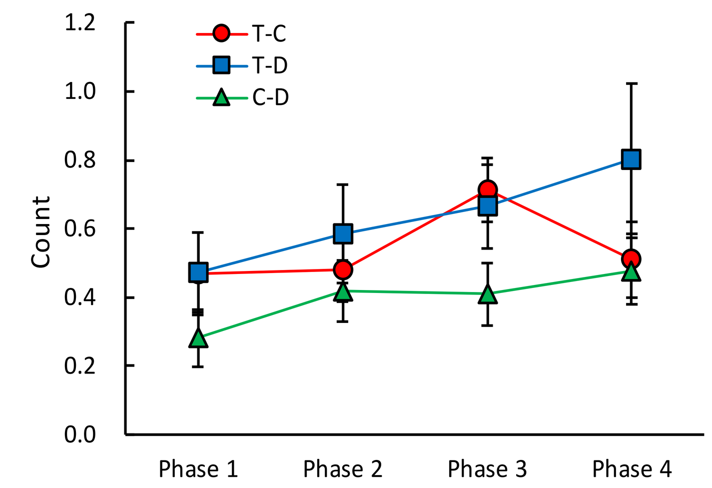

Figure 6. Number of attribute-wise saccades in the **compromise** effect condition (**competitor** chosen).

Time-series Analysis of Saccades

We divided each whole decision time into four phases and performed a time-series analysis. We counted the number of the attribute-wise saccades between the upper or lower attribute of two alternatives and summed them as the total attribute-wise saccades.

In the attraction effect condition (target chosen by participants, Figure 3), a two-way ANOVA indicated significant main effects of the type of the pairwise comparison and the phase, and a significant interaction ($F(2, 60) = 15.94$, $p < .001$, $\eta_p^2 = .35$; $F(3, 90) = 6.91$, $p < .001$, $\eta_p^2 = .19$; $F(6, 180) = 3.25$, $p < .001$, $\eta_p^2 = .10$, respectively).

In the attraction effect condition (competitor chosen by participants, Figure 4), a two-way ANOVA indicated significant main effects of the type of the pairwise comparison and the phase, and a significant interaction ($F(2, 62) = 8.87$, $p < .001$, $\eta_p^2 = .22$; $F(3, 93) = 18.13$, $p < .001$, $\eta_p^2 = .37$; $F(6, 186) = 3.70$, $p < .001$, $\eta_p^2 = .11$, respectively).

In the compromise effect condition (target chosen by participants, Figure 5), only the main effect of the phase was significant ($F(3, 84) = 13.61$, $p < .001$, $\eta_p^2 = .33$).

In the compromise effect condition (competitor chosen by participants, Figure 6), the main effect of the type of the pairwise comparison and the phase were significant ($F(2, 56) = 3.91$, $p < .05$, $\eta_p^2 = .12$; $F(3, 84) = 2.75$, $p < .001$, $\eta_p^2 = .09$, respectively).

Discussion

Theoretically, each sequential span of decision making corresponds to (1) initial screening, (2) evaluation and comparison, and (3) validation before decision making (Glaholt & Reingold, 2011; Noguchi & Stewart, 2014). In the attraction effect condition, the time-series analysis revealed significant dynamic aspects of pairwise comparisons in the interaction of two factors. However, in the compromise effect condition, this interaction was not significant. In the attraction effect condition, it is important, especially in the third phase, that the frequency relations of the three types of comparisons noticeably differ by the final decisions (target or competitor).

These results, together with our previous research (Tsuzuki et al., 2015, 2019), suggest that the empirical examination of computational models based on multiple physiological process-tracing measures is imperative to reveal the mechanisms underlying context effects in multi-alternative decision making.

References

Tsuzuki, T., & Busemeyer, J. R. (2012). A multi-measure analysis of context effects in multi-attribute decision making: Examining the similarity, attraction, and compromise effect. *Proceedings of the 34th Annual Conference of the Cognitive Science Society*, 1054–1059.

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