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Abstract

This study explores the influence of rewards on visual search termination and efficiency, addressing whether the presence of a reward affects participants' willingness to terminate the search process. Using the web platform Gorilla, we conducted a visual search task with undergraduate participants from Carnegie Mellon University, where we associated stimuli colors with reward points exchangeable for candy bars. Contrary to expectations, results showed no significant effect of reward availability on visual search termination and efficiency. While previous literature has shown that reward availability enhances search performance, our study suggests that the nature of the rewards may influence this positive relationship between reward availability and search performance. Future research could be conducted to explore the impact of different reward types on search performance as this would be invaluable in understanding human motivation and performance optimization.

Introduction

Visual search, a cognitive process in which individuals locate a target among distractors, plays a pivotal role in everyday activities. However, a crucial aspect of this process lies in understanding how reactive rewards influence their efficacy and conclusion. Research indicates that the introduction of rewards enhances search efficiency. This insight extends beyond academic interest to hold tangible real-world applications. For instance, consider the scenario of locating misplaced car keys: the promise of a reward, such as buying ice cream upon finding the keys, can sharpen one's focus, motivation, and determination. This heightened state of arousal can lead to improved attentional focus, quicker decision-making, and enhanced cognitive flexibility—all of which are crucial for successful visual search.

In this study, participants completed a 15-minute experiment on the web platform Gorilla where participants responded to stimuli by pressing "F" on the keyboard for present and "J" for absent, with rewards associated with specific stimuli colors, and points accumulated for correct responses exchanged for candy bars. Results show that participants' mean reaction time was significantly longer when the target was present than when the target was absent, as expected. However, although the mean reaction time was slightly longer when the stimuli color was associated with rewards, it was not significant,

contrary to expectations. This either suggests a flaw in our design or raises the possibility that other factors such as the nature of the reward may be influencing outcomes.

Methods

Participants

A group of 17 undergraduate students from Carnegie Mellon University took part in our experiment. All participants have signed a consent to be part of the experiment.

Stimuli

All stimuli were presented against a white background. Each trial consisted of a fixation display, a search display, and a feedback display. The fixation display consisted of a black cross at the center of the screen, lasting approximately 500 ms. The search display consisted of an array of distractors (marked as "L") and potentially a target (marked as "T"). The target could be upside down or right side up. Distractors and targets shared the same color, alternating between green and pink for each trial (refer to Figure 1). The feedback display gave participants one of three possible responses: correct, incorrect, or too slow. If their response was correct and matched the reward color, they advanced to another display. This subsequent display congratulated them, stating, "You've earned 10 points!" and informed them of their current score.

Figure 1

Note: This figure demonstrates two trials, the left side being a pink-stimuli trial with the target absent and the right side being a green-stimuli trial with the target present.

Procedure

The study was conducted through a Gorilla survey. The study took about 15 minutes to complete. Participants began with 20 practice trials, consisting of 10 target-absent and 10 target-present trials. During these trials, participants encountered both pink and green

stimuli; however, none of these trials were associated with rewards, as they served solely as practice sessions. Participants were told to press “F” on their keyboard if they believed the target was present and “J” if they believed it was absent. No feedback was given during these practice sessions.

Afterwards, participants proceeded with the actual experiment. In one group, green stimuli were associated with rewards, while pink stimuli were not. In another group, the association was reversed, with pink stimuli associated with rewards, and green stimuli not associated with rewards. The actual experiment comprised a total of 200 trials, with 50 trials for each condition (reward-present, reward-absent, no reward-present, no reward-absent). Feedback, including incorrect, correct, or too-slow displays, was provided after each trial. If a participant took longer than 2 seconds to respond, the “too slow” display would appear. Additionally, if a participant correctly responded on a pink-stimuli trial where pink was associated with rewards, 10 points would be added to their score count. The same rule applied to green stimuli. By the end of the 200 trials, participants could exchange every 300 points earned for a choice of candy bar.

Results

Overall, the participants’ mean reaction time was 1161 ms. The mean reaction time was slightly longer when in the reward condition than in the non-reward condition [1172 ms versus 1150 ms]. However, ANOVA results showed that the reward did not have a significant effect on reaction time ($p = 0.189$). Furthermore, the mean reaction time was longer in instances where the target was absent compared to when it was present [1321 ms versus 1002 ms]. This disparity in reaction time demonstrated a significant main effect of target presence on reaction time, as evidenced by the results of the ANOVA analysis [$F(1, 2995) = 365.19$, $p < 0.00001$].

Figure 2 illustrates the average reaction time of participants under different conditions, considering the presence or absence of the target, alongside the presence or absence of a reward. In the depicted trials where the target is absent, the reaction time was slightly longer in reward than in no reward (1328 ms versus 1313 ms). Similarly, in trials where the target is present, the reaction time was slightly longer in reward than in no reward (1016 ms versus 987 ms). However, ANOVA revealed that there was no interaction effect between target presence and reward on reaction time ($p = 0.664$).

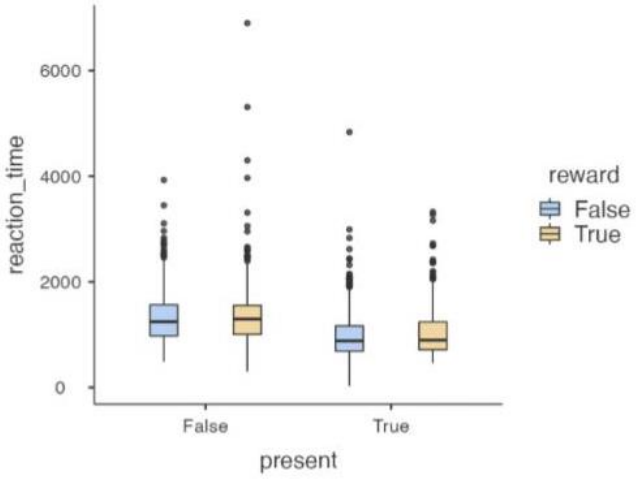

Figure 2: This boxplot demonstrates that the reaction time when target is absent stays relatively consistent regardless of the presence of reward. Similarly, the reaction time for when present is present remains relatively consistent regardless of the presence of reward.

Discussion

The study aimed to investigate the impact of reward availability on visual search termination. Several studies in the past have found an increase in search efficiency in conjunction with reward (Kang et al., 2023; Kristjánsson et al., 2010). These studies have shown that reward anticipation leads to an increase in search performance. Thus, we hypothesized that the reward would delay visual search termination, meaning the anticipation of the reward results in participants being less willing to terminate their search when targets are absent, thus leading to longer reaction times.

In the study, participants were presented with a standard visual search task where they were instructed to detect whether a target was present or not. For some participants, the pink stimuli were associated with rewards while for others the green stimuli were associated with rewards. The results of our study suggest that the hypothesis that reward delays visual search termination did not fully hold up. Although mean reaction times were slightly longer in the reward conditions compared to the non-reward conditions, the finding was not significant according to the ANOVA. Additionally, while reaction times were significantly longer in target-absent trials compared to target-present trials, there was no significant interaction effect between target presence and reward availability.

Thus, our data does not line up with the common consensus that rewards increase visual search efficiency, possibly due to differences in our experiment setup particularly

regarding the nature of the rewards provided. While many previous studies used monetary rewards, we utilized candy bars because of resource constraints (Anderson et al., 2011; Kang et al., 2023; Lee et al., 2022; Navalpakkam et al., 2009; Pearson & Le Pelley, 2020; Wolfe, 2012). This difference in reward type may have influenced participants' motivation levels differently thus leading to different subsequent search behaviors. Future research might consider different reward types and their impact on search efficiency and search termination.

The results of our study were inconsistent with the common consensus that reward delays search termination and enhances search efficiency. However, our intention is not to debunk the common consensus but to acknowledge the multifaceted nature of search termination and efficiency, especially about varying types of reward and how they may influence individuals' search behaviors. In a sense, our study also focuses on motivation levels and search performance, offering a broader implication. One can establish frameworks to optimize overall performance by understanding motivation levels and search performance.

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