Perceptual representations of physical properties: Grasp preparation and the relation between object size and weight on change detection

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Abstract

The present study examined the relationships among object weight and size, grasp preparation, and the detection of change in the perception of visually displayed objects. In a 4 X 2 (grasp condition X detection condition) mixed factorial design, 68 subjects were randomized into one of four conditions. Subjects were instructed to grasp one of four differently sized and weighted balls: a large, heavy ball; a large, light ball; a small, heavy ball; and a small, light ball. All subjects grasped a ball while participating in a change-detection flicker task in which subjects watched a computer screen while two slightly differently images flicked back and forth with a flicker screen being displayed for 500ms in between the alternating images. Once the subjects detected the object that had changed in the scene, they were instructed to press a key and select the object which was perceived to have changed. They completed a practice session of 6 trials followed by the test session of 6 trials. The grasping conditions are the independent variables, and reaction time in the change-detection task is the dependent variable. We hypothesized that change detection would improve for conditions in which the grasped object's weight and size were congruent with the changed object in the visual display. Thus, subjects were predicted to detect the specific scene change significantly more quickly when the size of the ball being held was similar to the object in the scene which happened to be changing.

Introduction

Since Neisser and Becklen (1975) there has been considerable interest among psychologists in a domain referred to as change blindness or inattentional blindness. In particular, a study by Simons and Chabris (1999) jump-started a wave of studies about this psychological tendency. There have been many aspects of the phenomenon which have been explored extensively, but the main findings within the research are that people are apt to not perceive apparently obvious changes in their immediate visual field unless their attention has been in some way directed towards the actual change or at least prompted, cued, or primed to notice the change. Research on change blindness has overlapped considerably with a related construct referred to as *change detection*. Here it is not so much the lack of perception that is important but the time it takes subjects to notice an apparent change. More recently, researchers have used change detection itself as a dependent variable to measure perception of other psychomotor factors and the complex interaction between the physiologic sensations, physical objects, and cognitive representations. A paper published by Symes, Tucker, Ellis, Vainio, & Ottoboni (2008) demonstrated that change detection improved when the changing-object displayed on a computer screen had similar dimensions to an object that was actually being grasped by subjects (e.g., they used images of fruit arranged randomly on the computer screen). Likewise, when the size of the changing-object displayed was disparate from the grasped object (either too large or too small) change detection was relatively poor. The paper had four studies within it, and was impressive in its thoroughness. However, we wondered if, while the physical dimension of size was demonstrated to be important for change detection, could the dimension of weight or density also have an influence? This study will replicate aspects of Symes, et. al. (2008) while extending the research to explore the effects of object weight/density of grasped objects on the change detection of perceived objects in the visual field.

Method

Participants

Sixty-eight subjects were recruited and 14 Ss were excluded for failing to adequately notice any changes in the scenes. Thus, 54 subjects were used in the study. They were randomly selected from the SNHU campus and randomly assigned to 1 of 4 object-grasping conditions.

Materials

- 4 white round balls:
  1. a ball weighing 5 oz., 8 in. in circumference
  2. a ball weighing 1 oz., 8 in. in circumference
  3. a ball weighing 2 oz., 1 in. in circumference
  4. a ball weighing 0.1 oz., 1 in. in circumference
- Dell Computer with *Superlab* Stimulus Software Package used to present 2 sets (large object and small object) of 3 change-detection tasks
- Demographic Form

Procedures

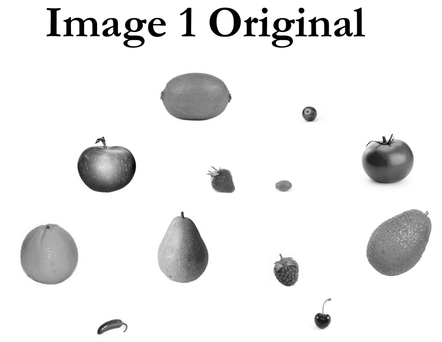
All subjects completed consent and demographic forms. Subjects were randomized into 1 of the 4 ball conditions, and they sat at the computer approximately 2-2 ½ feet away while holding the ball throughout the change-detection trials. The computer screen displayed the directions, followed by a presentation of 6 practice trials which were then followed by the 6 test-phase change-detection flicker tasks.

<u>Change Detextion Flicker Tasks</u>:

For each of the 6 trials, subjects viewed an image of an arrangement of twelve pieces of fruit for 500ms; then a blank flicker screen for 500 ms; and then the fruit arrangement image with 1 altered piece of fruit (for example and apple was switched for a peach) for 500 ms.. This series cycled through until the subject noticed the change, at which point he/she would acknowledge the change by pressing the space bar. Then a screen appeared with the original fruit arrangement image with numbers next to each piece of fruit, and subjects pressed the number corresponding to the fruit that he/she believe had changed. This was repeated for the remaining 5 test trials.

Here is an example of the series of images for the change-detection flicker tasks:

Image 1 Original



Flicker

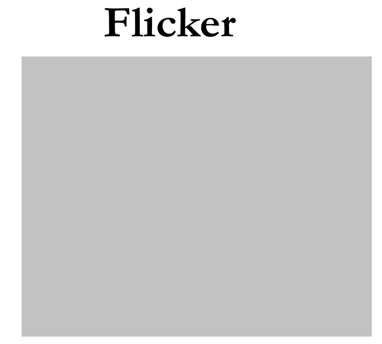
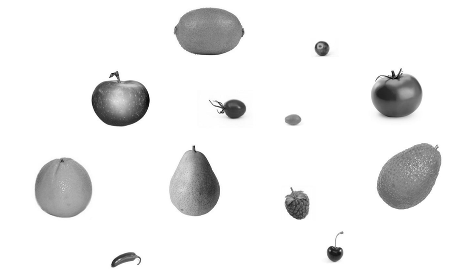


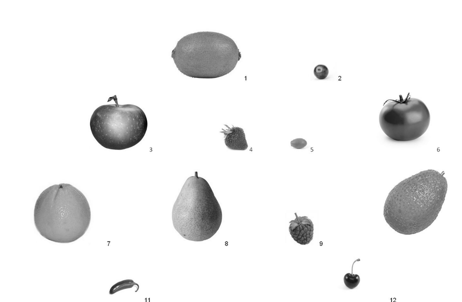
Image 1 Altered



Flicker

These 4 images were displayed for 500ms each and would cycle through until the subject detected the changed fruit.

Image 1 Numbered



This final image was used to confirm that the subject actually detected the changed object.

Results

<u>Descriptive Statistics</u>

Mean Reaction Times for Change-Detection of Small Objects by Condition (in seconds)

Grasp Condition	Mean	SD
Large/Heavy	22.8*	7.5
Large/Light	29.0	10.0
Large Total:	*26.0*	*9.3*
Small/Heavy	24.3	10.6
Small Light	27.3	5.5
Small Total:	*25.8*	*9.1*

Mean Reaction Times for Change-Detection of Large Objects by Condition (in seconds)

Grasp Condition	Mean	SD
Large/Heavy	33.6*	11.2
Large/Light	26.8	9.9
Large Total:	*30.1**	*10.9*
Small/Heavy	23.8*	9.0
Small Light	29.6	11.0
Small Total:	*26.6*	*10.3*

Main Effects for Multiple Analysis of Variance

Variable	F-value	Sig.
Grasped Object Size	0.94	0.478
Grasped Object Weight	2.34	0.047*

Interaction Effects for Size & Weight $F = 2.51$, $p = 0.035$*

Discussion

Overall, we detected some statistically significance differences among the conditions in our study. However, contrary to our hypothesis– and previous findings– we did not find the congruency of grasped-object and changed-object detection speed. For example, overall, large objects being grasped led to *longer* reaction time in the large change detection condition. And the fastest reaction time overall was for subjects assigned to the large/heavy condition when detecting small-object changes. Likewise, the second fastest reaction time was for Ss in the small/heavy condition when detecting changes to large objects.

Therefore, when combined, we did not find any main effects for object size. However, we did find main effects for object weight, and this seems to be a novel finding within the literature. Previous studies have focused solely on object size, regardless of weight. That is, overall, change detection was statistically significantly faster for Ss grasping a heavier object than a lighter object regardless of size ($F = 2.34$, $p = .047$). Another novel finding for the study seems to be that of the interaction effects between grasped object size and weight on change detection ($F = 2.51$, $p = .035$). That is, there was a statistically significant disparity on change detection for Ss grasping the large, heavy object between the small-object and large-object tasks (22.8 seconds vs. 33.6 seconds).

While the results of our study were not entirely consistent with our hypotheses, we believe we have developed a promising new line of inquiry into the added complexity of object weight, beyond object size, to the change blindness and change detection literature. More research should be conducted to further untangle the complicated interactions hinted at in this project.

References

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