

Examining the Role of Object Size in Judgments of Lateral Separation

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Abstract

Research on depth judgments has found a small but significant effect of object size on perceived depth (Gogel & Da Silva, 1987). Research on judgments of separation (e.g., Levin & Haber, 1993), however, has found that visual angle is the predominant determiner of exocentric distance judgments. The goal of the present research was to examine the influence of object size on judgments of lateral separation using a one-shot change detection paradigm. Experiment 1 used a forced-choice response, finding a significant influence of object size on distance judgments. Experiment 2 replicated these results using a distance reproduction task. These results are discussed in terms of Gogel and Da Silva's (1987) Theory of Off-Sized Perceptions.

Keywords: distance estimation; perception; spatial cognition; change detection;

Introduction

The ability to recognize objects and judge distances is essential for navigating through the environment. During object recognition, an observer will automatically determine its *angular size* and, in many cases, then perceive the object as having an expected size or range of acceptable sizes (i.e., its *familiar size*; Haber & Levin, 2001). For instance, once a student recognizes that an object on a table is a beer bottle, the student has access to its familiar size (around 20 cm tall). This metrical size judgment is also referred to as the *linear size* of an object. In addition to size perception, there are two types of distance perceptions: egocentric and exocentric. *Egocentric* distance perception is the perception of an object in depth, that is, a judgment made of the distance between one's self and an object. Using a football analogy, it is the kind of perception that the quarterback uses when he decides how far to throw the ball downfield to reach his receiver. *Exocentric* distance perception is the perception of inter-object distance, that is, a judgment made of the distance between two objects irrespective of observer position. Returning to the football analogy, exocentric distance perception arises, for instance, when the quarterback estimates the distance between his wide receiver and the opposing team's defensive back.

Size-Distance Invariance

The size-distance invariance hypothesis (SDIH) was an early attempt to capture the relationship between size and distance perception (Filpatrick & Ittelson, 1953). It states that observers expect that an object at a relatively farther distance will project a smaller retinal image size than the same object at a relatively closer distance. While the majority of size and distance judgments are consistent with this hypothesis, task instructions and certain visual illusions have generated apparently contradictory evidence (Epstein, 1963; McCready, 1985). For instance, when observers are

asked to judge how far away an object feels to them (a judgment of *apparent distance*), their answers tend to ignore familiar size cues and correspond more to the object's angular size. If instead observers are asked to judge how far away an object would be if measured with a meter stick (its *objective distance*), then their answers tend to be influenced by familiar size cues. No process specified in the size-distance invariance hypothesis captures the effect of task instruction on size and distance judgments.

In addition, visual illusions have also provided evidence not captured by the SDIH. For instance, the zenith moon appears both smaller and farther away than the horizon moon, a finding that is inconsistent with the size-distance invariance hypothesis (Kaufman & Rock, 1962). The size-distance invariance hypothesis instead predicts that when the moon appears smaller at its zenith, it should appear closer than when along the horizon, not farther away. This incongruence is called the size-distance paradox.

Dissociating Perceived Size and Cognitive Size

To account for the differential effect of task instruction and illusions such as the size-distance paradox, the SDIH was modified to represent a relation between apparent size, apparent distance, and (arguably) apparent visual angle (McCready, 1985). This single-process model of size and distance perception presupposed that size judgments could not dissociate linear size determined primarily by angular size from linear size influenced by familiar size and other "cognitive" cues. In other words, *perceived* linear size and *cognitive* size judgments could not be disentangled and were thus part of an encapsulated process.

To test the single process model, Gogel (1976) developed an indirect head-motion tracking technique to measure perceived egocentric distance. He found only a negligible effect of familiar size on perceived distance. Observers made both verbal and head-motion judgments of the distance of similar-sized transparencies of three familiar objects (a key, sunglasses, and a guitar) whose sizes simulated distances of 63 cm, 185 cm, and 1236 cm respectively. The actual distance of the transparencies was 133 cm. Familiar size cues influenced verbal reports of distance and, to a lesser extent, head-motion responses. The actual size of a guitar is 19.6 times the size of the key. Nonetheless, the transparency of the guitar was reported to be only 10 times the size of the transparency of the key for verbal reports and 1.4 times the size of the key in head-motion responses. This result is noteworthy considering that the study used apparent instructions, which should have reduced the effectiveness of familiar size cues. While both verbal reports and head-motion responses exhibited familiar size effects, they were much more pronounced in the verbal reports. This evidence suggested that the cognitive size

predominantly influenced only direct (e.g., verbal) reports of distance and not *raw* representations of perceived distance (Mershon & Gogel, 1975). The head-motion technique experiment results led to the conclusion that perceived size (determined by angular size) and distance could be dissociated from cognitive judgments of size and distance.

The Theory of Off-Sized Perceptions

Consequently, Gogel and Da Silva (1987) postulated a two-process theory, called the *theory of off-sized perceptions*. The primary process is *perceptual* and is consistent with the SDIH. The secondary process is *cognitive* and is influenced by top-down memory effects such as familiar size cues. Attention, the availability of visual cues, and experiment instructions determine the extent to which the secondary process influences distance judgments. For instance, when an object is perceived as off-sized (i.e., when its perceived size is different than its expected or familiar size), this more heavily weights the *cognitive* secondary process. The evidence used to support the theory of off-sized perception has exclusively been based on judgments of depth. Thus, it has been shown to be valid for egocentric judgments only.

While the theory is claimed to be a generalized model for size and distance perception, it has also been argued that egocentric and exocentric judgments subsume separate processes (Gogel, 1965). Therefore, it is not clear that the theory of off-sized perceptions can be applied in the same manner to exocentric distance judgments or to judgments of lateral separation, which are a depth-controlled subset of exocentric distances. There is evidence, however, that egocentric distance judgments and judgments of lateral separation do use similar processes. Sterken, Postma, De Haan, and Dingemans (1999), for instance, used a change detection task to determine whether egocentric distance and lateral separation information are independently stored in visual memory. They showed that co-occurring lateral displacement reduced the accuracy of egocentric judgments below-chance levels. Similarly, co-occurring egocentric displacement reduced the accuracy of judgments of lateral separation to at-chance levels. This interference between egocentric and lateral separation information indicates that representations of egocentric distance and lateral separation are correlated.

Experiment 1: Forced-Choice Task

The objective of this experiment was to use a one-shot change detection task to determine the role that object size plays in judgments of lateral separation. Prior research has argued that visual angle is the predominant cue in exocentric distance perception (Levin & Haber, 1993). In other words, when both depth and separation (i.e., angular size) vary, observers tend to judge distance using the separation between objects and ignore relative depth and size cues.

Gogel and Da Silva's (1987) two-process theory of off-sized perceptions, however, predicts that only the primary perceptual representation should be derived from angular size (i.e., visual angle). The representation generated from

the *cognitive* secondary process utilizes top-down information such as familiar size cues to calibrate distance judgments. When an object is perceived as off-sized this weights the cognitive effects of the secondary process.

By independently manipulating familiar size cues (object size) and visual angle (lateral separation), it is possible to determine if familiar size cues affect judgments of lateral separation in a manner that is consistent with the theory of off-sized perceptions (Gogel, 1998). By changing object size between the source and target images, participants should perceive the objects as off-sized, which, in turn, should more heavily weight the secondary process in the distance judgment and reduce accuracy in the present task.

Consequently, participants were asked to detect changes in lateral separation. If visual angle is the predominant determiner of exocentric distance as theorized by Levin and Haber (1993) and Matsushima et al. (2005), then changes in object size should not significantly affect the accuracy of judgments of lateral separation. If, however, the familiar size cue is also a significant determiner of judgments of lateral separation, then changes in object size should reduce the accuracy of inter-object distance judgments consistent with the theory of off-sized perceptions.

Method

Participants

Thirty Carleton University undergraduate students were awarded extra course credit for their participation. All participants exhibited normal or corrected-to-normal vision.

Materials

The source image consisted of two identical white squares appearing on the central horizontal axis of the computer screen (see Figure 1). They were placed at equal distances from the center of the display. On half of the trials, the objects were arranged horizontally (left and right of the centre of the screen) and on half of the trials they were arranged vertically (above and below the centre of display).

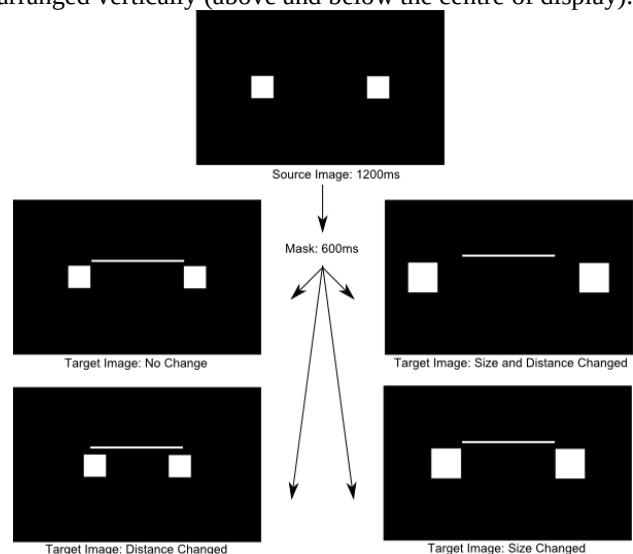


Figure 1. Sample conditions from the one-shot change detection methodology. The bar above the squares in the target images represents the original separation from the source image. They are included for illustrative purposes and were not shown to the participants.

White squares were selected to ensure that the objects had no features which might promote cues other than relative size and familiar size. The squares' identical sizes also controlled for the perception of the relative depth of the objects as being perpendicular to the observer and equidistant (Gogel & Harker, 1955). Moreover, plain shapes are unlikely to cue prior knowledge, such as prototypical sizes of objects influencing the perception of scale.

The objects in the source image had three possible sizes (1.05°, 1.45°, & 1.85°). The objects' size in the target image either remained the same as in the source image or were varied in the target image by $\pm 0.20^\circ$ or $\pm 0.40^\circ$. The initial distance between objects in the source image was generated using multiples of initial object size, ranging from 2, 3, or 4 objects apart. Either the source and target image remained unchanged or one of three possible types of changes occurred in the target image: a change in object-size, a change in inter-object distance, or both a change in object-size and inter-object distance.

The pattern mask consisted of a randomly-generated static white-noise image with a dot-density of 34 dots per square cm. This image served both to mask the previous pattern and to eliminate any retinal afterimage which could otherwise have been used as an index of spatial position.

Apparatus

The present research was developed using the VisionEgg Toolkit (Straw, 2008). The stimuli were presented on a 24" LCD monitor with a screen brightness of 400cd/m² and a 2 ms response. The desk and walls were covered with a minimally-reflective black plastic to reduce the contrast and salience of the wall texture. To control for accommodation and parallax cues (Gogel, 1976), a chin rest was placed at a fixed height of 100 cm such that participants' eyes were centered on the monitor at a distance of 60 cm. An office chair was used to fit each participant to the equipment. Responses were recorded on a three-button mouse.

Procedure

Upon entering the experiment room, participants sat at the computer and had their chair adjusted such that they were sitting centered in front of the monitor with their chin comfortably on the chinrest. They were then instructed to fixate on the center of the screen.

A trial consisted of two sequentially-presented images separated by a white-noise mask. First, a source image was presented for 1200 ms followed by a 600ms randomized white-noise mask. Durations for stimuli presentation were derived from a similar one-shot change detection task in Cole et al. (2003). Presenting the mask for 600 ms minimizes the possibility that a change in object size or a change in separation be perceived as a change in depth (Rensink, 2002). Instead, depth should be specified by the convergence of participants' eyes fixated on the physical distance of the display.

On each trial, participants indicated whether the distance between the two objects was different in the target image when compared with the source image. They were provided with three possible responses: closer, same, or farther.

Participants were instructed to respond with their first impression of distance, consistent with apparent task instructions (Epstein, 1963). They were further directed to respond as fast as possible without sacrificing accuracy. No feedback was provided regarding the accuracy of their responses.

A short four-trial practice phase familiarized participants with the experimental procedures. In total, 216 trials were completed during the experimental phase. This included 36 baseline trials where neither size nor distance was changed between the source and target image (i.e., the source and target images were identical). The 180 remaining trials were divided among three change types: 72 in both the size-change and congruent change conditions, and 36 trials in the distance-change condition. The 72 size- and congruent change trials included an equal number from the three initial sizes (1.05°, 1.45°, 1.85°), three initial distances (2, 3, 4 object-multiples apart), four size-change or congruent changes (increase and decrease by 0.20° and 0.40° of visual angle), and two orientations (horizontal and vertical presentation). There were fewer trials (36) in the distance-change condition because participants exhibited ceiling performance at the $\pm 0.20^\circ$ distance change levels in pilot studies, thus the decision was made to eliminate the $\pm 0.40^\circ$ distance change trials from the experiment. Otherwise, trial order was randomized across participants.

Results and Discussion

One participant was excluded from all analyses because he failed to follow procedures. The remaining 29 participants' results were entered into all subsequent analyses.

Two separate 4(change type: no-change, size-change, distance-change, congruent change) $\times$ 3(initial distance: 2, 3, or 4 object-multiples) $\times$ 2(orientation: horizontal, vertical) repeated-measures ANOVAs were conducted for accuracy (i.e., proportion correct) and response times (in ms). Adopting the analyses of a similar change detection task from Henderson and Hollingworth (1999), data were collapsed across the objects' initial size. In the present analyses, 14 responses (0.23% of trials) were excluded due to having no response or RTs exceeding 10 s.

When Mauchley's test of sphericity was violated, Greenhouse-Geisser adjusted values were reported. All $ps < .001$ unless otherwise indicated and all post-hoc analyses are reported with pairwise Bonferroni-adjusted values.

Accuracy

The main effect of change type was significant, $F(1.90, 53.2) = 41.08$, $MSE = 6.67$, $\eta_p^2 = .595$. Participants were most accurate on distance-change and no-change trials ($M = .83$ and $.74$), followed by size-change and congruent change trials ($M = .61$ and $.48$). These results are consistent with the interpretation that changing object size between the source and target images causes observers to make an off-sized perception, which, in turn, more heavily weights the secondary cognitive process and reduces overall accuracy.

The main effect of initial distance was also significant, $F(2, 56) = 14.74$, $MSE = .363$, $\eta_p^2 = .345$, with farther distances resulting in reduced accuracy ($M = .70, .67, .62$).

for 2, 3, and 4 objects-apart initial distance, respectively). This result is consistent with visual angle having a reduced influence on judgments of separation because the accuracy of visual angle judgments is relatively lower at greater eccentricities (Matsushima et al., 2005).

The initial distance x change type interaction was also significant, $F(6, 168) = 19.96$, $MSE = .014$, $\eta_p^2 = .416$. Accuracy decreased with farther distances for three of the change types (no-change, size-change, distance-change), but increased for congruent change trials (see Figure 2). This reversal may be due to the reduced effectiveness of visual angle at farther separations. In the congruent change type trials, relative size cues indicate that the distance judgment should be “same” because object size and visual angle both change in proportion between the source and target images. The judgment from relative size cues conflicts with the judgment indicated by visual angle cues. Visual angle cues instead indicate that the response should be “closer” or “farther” because the visual angle has changed.

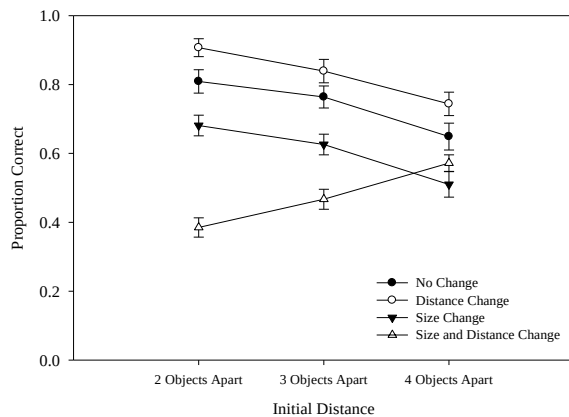


Figure 2. The Interaction between Initial Distance and Change Type for Accuracy. Error bars represent Standard Error.

At closer initial distances, it appears that relative size cues are more effective, which overrides visual angle as a cue (which should also be more effective), thus resulting in more errors. At the farthest 4-object initial distance, however, the effectiveness of the relative size cue likely is reduced and distance judgments become more accurate. In fact, at the farthest distance, post-hoc tests reveal that only the accuracy of distance-change trials are different than the accuracy for the congruent, size, and no-change trials. Finally, there was no main effect of orientation on accuracy, $F(1, 28) = .406$, $MSE = .012$, $p = .529$, $\eta_p^2 = .014$, nor was orientation present in any significant interaction.

Patterns of Errors

The previous analyses have identified that trials where object size changes (i.e., size-change and congruent change) have reduced accuracy compared to baseline no-change trials. These results, however, do not identify whether the kinds of errors support the hypotheses that off-sized perceptions occur when object size is modified. Responses are judged to be erroneous when participants make an inaccurate inter-object distance judgment, that is, when they

incorrectly report no change (or the wrong change) in distance when distance was varied, or they incorrectly report a change in distance when distance remained unchanged.

Table 1
Frequency of Response Type Examined Across Changes in Size and Distance.

		OBJECT SIZE		
Distance	Response	No Change	Smaller	Larger
No Change	CLOSER	68 (25%)	60 (12%)	180 (54%)
	SAME	772	563	712
	FARTHER	202 (75%)	431 (88%)	151 (46%)
		Binomial	$p < .001$	$p = .061$
Decrease	CLOSER	415	417	^a
	SAME	88 (82%)	534 (85%)	
	FARTHER	19 (18%)	93 (15%)	
	Binomial	$p < .001$	$p < .001$	
Increase	CLOSER	16 (23%)	^a	34 (7%)
	SAME	54 (77%)		435 (93%)
	FARTHER	451		574
	Binomial	$p < .001$		$p < .001$

Note. Numbers **bolded** indicate the number of correct responses. Percent values represent breakdown of response type among only incorrect responses. Exact binomial test assesses proportion of incorrect responses based on 50% chance.

In examining incorrect response frequencies (see Table 1), the proportion of incorrect responses occurring near-chance levels would be indicative that incorrect responses were simply guesses. The results instead indicate that participants were not guessing when responding incorrectly. Interestingly, in the baseline no-change trials, participants were three times as likely to incorrectly judge a distance farther than closer, despite the fact that neither size nor distance changed. It thus appears that participants are biased towards “farther” judgments. Binomial tests further revealed that in the size-change trials, when object size increases there are significantly more incorrect “closer” responses than in the baseline trials. Similarly, when object size decreased there were significantly more incorrect “farther” responses than in the baseline trials. These results are consistent with participants making large and small off-sized judgments, respectively.

In the congruent change trials, the majority of errors were “same” whether or not size increased or decreased. This finding implies that participants were not solely using the off-sized perception to assume that, for instance, a large off-sized perception results in a “closer” distance judgment. Instead, it appears that participants may have been assessing both changes in object size and changes in separation when making distance judgments.

Response Times

The main effect of change type was significant, $F(2.46, 69) = 18.21$, $MSE = 2420000$, $\eta_p^2 = .394$, with participants responding faster to no-change or distance-change trials ($M = 1255$ ms and 1294 ms) than trials involving size-change or congruent change ($M = 1404$ ms and 1418 ms). These results imply that participants were detecting the change in object size, and potentially, that some additional processing

was undertaken consistent with an off-sized perception more heavily weighting the secondary inferential process.

A main effect of initial distance was also significant, $F(1.60, 44.9) = 3.75$, $MSE = 257000$, $p = .040$, $\eta_p^2 = .118$, such that participants responded more slowly when initial distances were greater ($M = 1288\text{ms}$, 1326ms , 1347ms for 2, 3, and 4 objects-apart distance). Although this main effect was significant, post-hoc tests identified no significant difference in RTs between distances ($ps > .108$). Unlike the accuracy results, there was no significant interaction between change type and distance. This implies that different distances do not engage separate judgment processes. Finally, there was no effect of orientation on RTs, $F(1, 28) = 0$, $MSE = 12.2$, $p = .989$, $\eta_p^2 = .000$.

In addition to examining overall RTs, a 4(change type: no-change, size-change, distance-change, congruent change) $\times$ 2(response accuracy: RTs for correct and incorrect response) repeated-measures ANOVA was also conducted to determine if there was evidence for differential processes implicated for correct versus incorrect responses. Overall, participants were faster on correct trials than on incorrect trials ($M = 1316\text{ ms}$ vs. 1495 ms), $F(1, 28) = 26.32$, $MSE = 1860000$, $\eta_p^2 = .485$, consistent with the assumption that participants were not just making a speed-accuracy tradeoff.

A more revealing result emerged from the significant response accuracy $\times$ change type interaction, $F(1.99, 55.7) = 9.297$, $MSE = 1230000$, $\eta_p^2 = .249$. Participants responded faster for correct responses (than incorrect) in three of the change types (477 ms faster in the no-change trials, 151 ms faster in the distance-change trials, and 191 ms faster in the size-change trials). However, participants responded faster for incorrect responses than correct responses (102 ms faster) in the congruent change condition. This reversal in RT latencies in the congruent change trials indicates that participants were not just taking longer to respond when unsure of their response. Instead, these results are once again consistent with the hypothesis that secondary cognitive processes were being activated when conflicting size information was present (e.g., off-sized perceptions).

In summary, Experiment 1 has shown that object size influences judgments of lateral separation consistent with the predictions from the theory of off-sized perceptions.

Experiment 2: Drag-and-Drop Task

The objective of this experiment was to replicate and extend the results of Experiment 1 by requiring participants to respond with a mouse to reproduce the distance from the source image. This can provide a quantitative measure of the weighting of familiar size cues on judgments of separation. In addition, this will provide additional evidence to determine why participants were three times as likely to incorrectly judge the separation “farther” than “closer” in the no-change condition in Experiment 1.

The theory of off-sized perceptions predicts that changes in object size should heavily weight inferential processes resulting in altered distance judgments. If changes in object size do not influence distance judgments, then dragging accuracy (measured in deviation from expected location)

should remain unchanged when object size changes. This lack of influence would support the view that visual angle is the predominant cue for distance perception. If, as seen in Experiment 1, changes in object size significantly influence the perception (and reproduction) of distance, then dragging accuracy should change linearly with changes in object size. For example, if object size is increased between the source and target images, then the reproduced distance should increase linearly with the degree of change in object size.

Method

Participants

Twenty-three Carleton University undergraduate students were awarded extra course credit for their participation. All participants exhibited normal or corrected-to-normal vision.

Materials and Procedures

The experimental stimuli consisted of the sequentially-presented images described in the Experiment 1. In the source image, two squares of equal size (the objects) were presented at an equal distance from the center of the screen. In the target image, one square was anchored on the screen in the same location as in the source image and grayed out, representing the fact that it could not be dragged. The other square was adjacent to the first, placed closer to the center of the screen. The initial object size, initial distance, and orientation were all the same as in Experiment 1. The anchored object was counterbalanced such that on half the trials the anchored object was to the left (in horizontally-presented trials) or above (in vertically-presented trials) the centre of the screen, and on half the trials the anchored object was to the right or below the centre of the screen.

Participants completed 180 trials. The trials were equally divided among five change types: size unchanged, size increased by 0.40° or $.20^\circ$ of visual angle, and size decreased by 0.40° or 0.20° of visual angle. Each change type included an equal number of trials from three initial sizes, three distances, two orientations, and two anchors.

Results and Discussion

Two separate 5(size-change: large-size-increase, small-size-increase, no-change, small-size-decrease, large-size-decrease) $\times$ 3(initial distance: 2, 3, or 4 object-multiples) $\times$ 2(orientation: horizontal, vertical) repeated-measures ANOVAs were conducted for accuracy (i.e., deviation) and response times (in ms). Deviation was measured as the difference between the dragged distance and the original distance presented in the source image. Similar to Experiment 1, data were collapsed across objects' initial size. In the present analyses, 27 trials (0.65%) were excluded for having either no recorded response or deviations more than 3 SD.

Consistent with the results of Experiment 1, the main effect of size-change type was significant, $F(2.16, 47.6) = 50.95$, $MSE = 11.16$, $\eta_p^2 = .698$. Participants exhibited the least dragging deviation when size did not change, followed by small size-change trials, and large size-change trials (see Figure 4). Within-subjects contrasts revealed that changes in object size linearly influenced the accuracy of distance

reproductions, $F(1, 22) = 80.34$, $MSE = 23.866$, $\eta_p^2 = .785$. These results support the interpretations from Experiment 1: object size influences the accuracy of distance judgments consistent with the theory of off-sized perceptions.

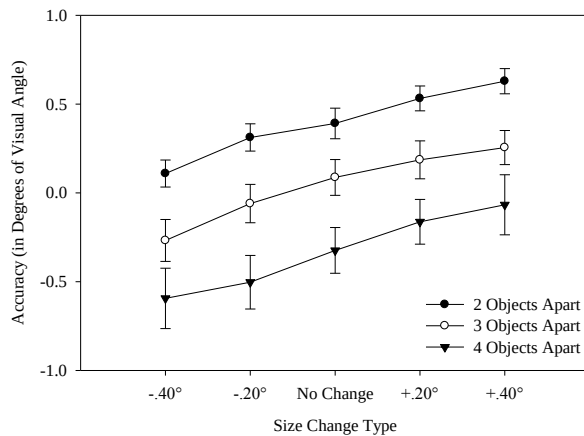


Figure 3. The Interaction between Initial Distance and Size-Change Type on Accuracy. Error bars represent Standard Error.

Additionally, the main effect of initial distance was also significant, $F(1.14, 25.0) = 35.67$, $MSE = 53.26$, $\eta_p^2 = .619$, with farther initial distances resulting in relatively increased amounts of underestimation. Within-subjects contrasts revealed that different initial distances exhibited linear changes in deviation, $F(1, 22) = 38.08$, $MSE = 60.434$, $\eta_p^2 = .634$. These changes in deviation may be due to participants' attention returning to a resting state during the pattern mask and feeding back into their prior perception of separation from the source image. It may also be the case that, however, because participants always dragged the mouse from zero separation, that the underestimation was in part due to a directional bias in the method of adjustment.

To more easily compare the results of the current experiment with those of Experiment 1, participants' accuracy was converted to categorical closer-, no-change, and farther-responses by determining 99% confidence intervals for trials where object-size remained unchanged for each participant, and computing all values below this interval as a closer-response and values above this interval as a farther-response. A z-test for proportions identified that similar proportions of response types were found between Experiment 1 and the current study ($z = .472$, $p = .637$ for no-change, $z = 1.36$, $p = .174$ for size decrease, and $z = 3.60$, $p = .001$ for size increase).

Response times analyses exhibited no significant results for distance after factoring out psychophysical dragging times, $F(1.28, 28.2) = 2.07$, $MSE = 422000$, $p = .138$.

General Discussion

Experiment 1 and 2 have shown that changes in object size reduce the accuracy of judgments of lateral separation in a manner consistent with the theory of off-sized perceptions (Gogel & Da Silva, 1987). Another possibility, however, is that participants were automatically scaling the depth in the target image according to the laws of perspective (Gregory,

1963). While this implies that a change in the angular size of the squares is detected (in a way analogous to an off-sized perception), participants could be observing the perceived size of the squares to be the same (i.e., size constancy) and modifying their perception of the objects' perceived depth which would affect the scale of the perceived separation. In Experiment 2, deviation in reproduced distance due to changing object size was only 17% to 42% of expected values, which reflects only partial size constancy. This could be due to perceived change in depth conflicting with the constant depth specified by the monitor, resulting in a weighted value.

There are several reasons why a perspective-based size constancy account may be questioned. First, mask durations are long enough so that there is no perceived motion to trigger a motion-based shift in perspective (Rensink, 2002). Second, perspective necessarily requires the detection of a change in angular size similar to that of an off-sized perception. Third, no participants self-reported a perceived change in depth on post-test questionnaires.

Finally, further works needs to be done to understand why participants tend to underestimate relatively farther distances and overestimate relatively closer distances. While the results are consistent with visual attention returning to rest during the pattern mask, there is no direct evidence of this occurring in the using the present task.

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