An aftereffect to discrete stimuli producing apparent movement and succession*

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After observing the sequential flashing of two lights that produced either the perception of apparent movement or the perception of the succession of two stationary lights, the presentation of the lights in the opposite direction produced the perception of a more rapid apparent movement or of a more rapid succession of the light flashes. These aftereffects suggest the presence of neural structures for the discrimination of sequential changes in spatial position which are subject to adaptation and respond with decreased sensitivity to the repetitive presentation of the two lights in a given spatial direction. The results are interpreted to support the hypothesis that the perception of apparent movement involves the excitation of specific neural mechanisms selectively responsive to sequential changes in stimulus position. An alternative hypothesis is that the perception of apparent movement involves an inference based on the separate registrations of the position of a stimulus at one point in time and the position of that stimulus at an earlier point in time.

Research has clearly indicated that a stimulus moving repetitively in a given direction appears to slow down during prolonged inspection (Goldstein, 1957; Taylor, 1963). There is also an increase in the perceived velocity of a stimulus that moves in the opposite direction (Scott, Jordan, & Powell, 1963). This effect has been interpreted as the result of the adaptation of neural mechanisms selectively responsive to the direction in which a stimulus moves (Sekuler & Pantle, 1967). The question of whether an aftereffect similar to that which occurs with real movement will occur with discretely presented stimuli that produce either the perception of apparent movement or the perception of the succession of two stationary stimuli has not been investigated. This paper reports two experiments that show that a directional aftereffect occurs with repetitive discretely presented stimuli for particular spatial and temporal intervals.

Two experiments were conducted to investigate the conditions that affect the aftereffect to successive stimuli. Experiment I was designed to determine whether an aftereffect occurs with the spatial and temporal intervals that produce apparent movement. The experiment also investigated how an O's knowledge of the direction of the apparent movement and the blocking of stimuli affect the occurrence of the aftereffect. Experiment II was designed to determine whether an

aftereffect occurs when an O perceives the stimuli to be successive. The experiment also investigated the occurrence of the aftereffect as a function of the spatial separation between the stimuli.

EXPERIMENT I

In Experiment I, the Os were required to judge the velocity of the apparent movement of a test stimulus presented in the opposite direction and in the same direction as the apparent movement produced by an adapting stimulus. An aftereffect due to the desensitization of neural mechanisms resulting from exposure to the adapting stimulus would cause an O to report an increase in the perceived velocity of the test stimulus when it appeared to move in the opposite direction, but not in the same direction, as the adapting stimulus.

Observers

Ten Os served in the experiment. The Os were paid volunteers who had no knowledge of the movement aftereffect. All had normal vision without correction.

Method

The O was seated at a distance of 8 ft from a board, painted black, on which the stimulus lights were mounted at eye level. The stimulus lights were miniature bulbs (CM49) placed behind .125-in.-diam holes covered with typing paper in order to diffuse the light. The stimulus lights were 4 in. apart (2.4 deg of arc). The luminances of the lights were 5.2 fL. An O was told to fixate at all times on a red neon light (GE51), which was constantly in view and was placed 4 in. above the midpoint of the two stimuli. An O's head was held in position by an adjustable headrest. The durations of

the lights and the time interval between successive light flashes were controlled by a sequence of timers in series. An oscilloscope was used to calibrate and check the time intervals. The durations of the lights were 50 msec. The rise time of the bulbs was approximately 10 msec, and the decay time approximately 40 msec.

Each O was run for 10 days. Nine experimental days followed a practice day. After being seated in the experimental room, an O was shown the arrangement of the stimulus lights and told that a stimulus presentation would consist of the successive flashing of two stationary lights. The room lights were then extinguished, and an O was shown that the successive presentation of two stationary lights can produce the perception of a single light moving in the direction of the second flash. The training session on the practice day was divided into three parts. During the first part of the training session, the successive flashes of the two lights were presented twice in a left-to-right direction. On the first presentation, the interstimulus offset-to-onset time interval (ISI) was 200 msec, and on the second presentation, the ISI was made either 400 or 75 msec. Each of the Os reported that apparent movement was perceived with these ISIs. An ISI of 200 msec gives rise to a slower apparent movement than does an ISI of 75 msec and to a faster apparent movement than does an ISI of 400 msec. An O was instructed to judge whether the apparent velocity of the stimulus on the second presentation was faster or slower than on the first presentation. The time interval between the two presentations of the stimulus lights was 1,500 msec. Approximately half way through the first part of the training session, the method of magnitude estimation was explained in detail. An O was told that the apparent velocity of the light on its first presentation would be called "10" and that he was to make a numerical estimate of the apparent velocity of the light on the second presentation relative to that on the first. The Os were informed about the correctness of each of their judgments throughout the first part of the training session. This part of the training session was continued until Os made accurate velocity judgments, i.e., an O reported numbers greater than "10" when ISI was 75 msec and numbers less than "10" when the ISI was 400 msec.

During the second part of the training session, the successive flashes of the two stimulus lights were presented 10 times in a left-to-right direction (adapting stimulus), and on the 11th presentation (test stimulus),

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Table 1
Means and Standard Deviations of the Number of Faster Judgments in Experiment I

Observation Conditions		Test Stimulus in Opposite Direction (10-1)			Test Stimulus in Same Direction (11-0)		
		ISI (Msec)			ISI (Msec)		
		120	200	280	120	200	280
A							
Uncertain and Unblocked	Mean	17.4	12.5	3.0	14.9	5.7	1.9
	SD	.6	1.5	1.5	2.0	1.3	1.6
B							
Certain and Blocked	Mean	16.8	11.2	3.2	14.2	6.8	2.1
	SD	.9	3.3	2.5	1.9	3.0	1.0
C							
Certain and Unblocked	Mean	17.1	11.9	3.7	14.2	6.1	1.7
	SD	1.1	1.8	2.5	2.7	1.5	1.0

Note—The mean number of same judgments when the test stimulus was presented with an ISI of 200 msec in the opposite direction was .9 in Condition A, 1.1 in Condition B, and 1.1 in Condition C. The mean number of same judgments when the test stimulus was presented with an ISI of 200 msec in the same direction was 2.4 in Condition A, 2.0 in Condition B, and 3.4 in Condition C.

either in the same left-to-right direction as the adapting stimulus or in the opposite, right-to-left, direction. A noiseless switch controlled the direction of the test stimulus. An O was instructed to assign the numerical value of "10" to the apparent velocity of the 10th presentation and to rate the apparent velocity on the 11th presentation relative to that on the 10th presentation. The E signaled the O before the 10th presentation of the adapting stimulus. The adapting stimulus was always presented at an ISI of 200 msec. The test stimulus on the 11th presentation was first presented at ISIs of 400 and 75 msec. The 400-msec ISI was gradually shortened until it was 280 msec, and the 75-msec ISI was gradually lengthened until it was 120 msec. During the third part of the training session, an O was run on the experimental conditions of Condition A, described below. During the second and third parts of the training session, the Os were not informed of the correctness of their judgments. One O was replaced after the practice day because he made over 30% errors in the third part of the training session.

On the first experimental day, an O was told that the procedure would be the same as in the third part of the training session except that the apparent velocity of the test stimulus on the 11th presentation could be the same velocity as well as faster or slower than that of the adapting stimulus on the 10th presentation. He would therefore be allowed to judge that the velocity of the test stimulus was the same as that of the adapting stimulus, i.e., call it "10." The O was told that he should not judge the velocity of the test stimulus to be the

same as that of the adapting stimulus unless he was firmly convinced that the velocities of the stimulus lights in the 10th and 11th presentations were the same.

In Experiment I, three different observation conditions were each run for 3 days. On each day, an O was presented with 36 trials. A trial consisted of 10 presentations of the adapting stimulus followed by the test stimulus. In Condition A, the trials were unblocked, and an O did not know whether the test stimulus on the 11th presentation would appear to move in the same or in the opposite direction to that of the adapting stimulus. The 36 trials in a day consisted of 6 trials each with the test stimulus presented at ISIs of 120, 200, and 280 msec in the same left-to-right direction as the adapting stimulus (11-0 in Table 1) and in the opposite, right-to-left, direction to that of the adapting stimulus (10-1). The 36 trials were presented in a different random order to each O. In Condition B, the trials were blocked, and an O knew whether the test stimulus on the 11th presentation would appear to move in the same or in the opposite direction to that of the adapting stimulus. The 36 trials were divided into four blocks of 9 trials each. The O was told the direction that the test stimulus would appear to move before each block of nine trials. The direction of apparent movement of the test stimulus was alternated over the four blocks of trials. In each block of 9 trials, 3 trials were presented with an ISI of 120, 200, and 280 msec. The order of the 9 trials within a block was determined randomly for each O. In Condition C, the trials were unblocked, but an O was informed at the beginning of a trial whether the test stimulus on the

11th presentation would appear to move in the same or in the opposite direction to that of the adapting stimulus. The procedure was the same as in Condition A except that before each trial an O was told whether the test stimulus was to move in the same or in the opposite direction.

Thus, in each observation condition, for each of the three ISI intervals, an O was presented with 18 trials when the test stimulus was presented in the same direction as the adapting stimulus and with 18 trials when the test stimulus was presented in the opposite direction to that of the adapting stimulus. At the beginning of each experimental session, an O was dark adapted for 10 min. This was followed by six practice trials chosen from the experimental conditions to be presented on that day. A 1-min interval separated the trials within an experimental session, and Os were given a 5-min rest period after 18 trials. The three observation conditions were partially counterbalanced. Two Os were run in the order ABC, two in the order BAC, two in the order BCA, two in the order CBA, one O in the order ACB, and one O in the order CAB. Each O was reminded frequently to maintain fixation and was checked to make sure that he continued to see apparent motion throughout the experiment.

Results

Table 1 presents the means and standard deviations of the number of faster judgments (out of a possible 18) that Os made as a function of the experimental conditions. The occurrence of an aftereffect may be evaluated by comparing the mean number of faster judgments when the test stimulus appeared to move in the opposite direction with the mean number of faster judgments when the test stimulus appeared to move in the same direction as the adapting stimulus. Under all experimental conditions, the mean number of faster judgments when the test stimulus appeared to move in the opposite direction was greater than when it appeared to move in the same direction. The overall significance of the mean differences in Table 1 was evaluated by a four-way analysis of variance (Os by Direction of the Test Stimulus by ISI by Observation Condition). Inspection of the standard deviations in Table 1 revealed that the variances under the different experimental conditions were not equal. We applied an arcsin transformation to the data in order to compensate for the reduction in variance accompanying high and low proportions. The analysis of variance revealed that the factors of ISI and the

direction of the test stimulus were both statistically significant [$F(2,18) = 207.1$, $p < .01$; $F(1,9) = 93.5$, $p < .01$], as was their interaction [$F(2,18) = 8.6$, $p < .01$].¹ As expected, the number of faster judgments varied with the test stimulus ISI. The difference in the number of faster judgments as a function of the direction in which the test stimulus appeared to move indicates the occurrence of an aftereffect. The ISI by Direction of the Test Stimulus interaction is the result of the fact that the difference between the number of faster judgments when the test stimulus appeared to move in the opposite and in the same direction as the adapting stimulus was greater when the ISI was 200 msec than when the ISIs were 280 and 120 msec.

Statistical tests of the differences between the mean number of faster judgments with an ISI of 200 msec when the test stimulus appeared to move in the opposite direction to the adapting stimulus were significant beyond the .01 level [$t(9) = 10.0$ in Condition A, 3.3 in Condition B, and 9.5 in Condition C].² It may be seen in Table 1 that the number of faster judgments did not differ as a function of the observation conditions [$F(2,18) = .35$, n.s.]. The fact that an O's expectation to see the test stimulus move in a given direction did not influence the aftereffect indicates that the effect is not the result of attention or of an O's expectation to see the light as moving in a given direction. The mean velocity estimates of the test stimulus, averaged over Os and observation conditions, when it appeared to move in the same direction as the adapting stimulus were 11.3 for an ISI of 120 msec, 9.8 for an ISI of 200 msec, and 8.5 for an ISI of 280 msec. The mean estimates when the test stimulus appeared to move in the opposite direction were 12.9 for an ISI of 120 msec, 10.9 for an ISI of 200 msec, and 9.0 for an ISI of 280 msec.

EXPERIMENT II

Experiment II was undertaken to determine whether a directional aftereffect would occur when an O perceived the stimuli as successive presentations of two stationary stimuli rather than as a single moving stimulus. In Experiment II, the Os were required to judge the quickness of succession of two light flashes.

Observers

Eight different Os served in the experiment. The Os were paid volunteers who had no knowledge of the movement aftereffect. All Os had normal vision or corrected-to-normal vision.

Method

Each O was run for 4 days. Three experimental days followed a practice day. The apparatus and procedure was similar to that of Experiment I. The training session was divided into two parts. During the first part of the training session, the successive flashes of the two lights were presented in a left-to-right direction. The stimulus lights were placed 2 in. apart (1.2 deg of arc). On the first presentation, the ISI was 450 msec, and on the second presentation, the ISI was either 620 or 280 msec. An O was instructed to judge whether the ISI between the two lights in the second presentation was greater or less than the ISI on the first presentation. At 450 msec, all Os reported the lights as successive, without any appearance of apparent movement. The durations of the lights were 50 msec, and the time interval between the two presentations of the stimulus lights was 1,500 msec. The 620-msec ISI was gradually shortened until it was 540 msec, and the 280-msec ISI increased until it was 360 msec. This procedure was then repeated with the stimulus lights placed 32 in. apart (19.2 deg of arc). The Os were informed about the correctness of their judgments throughout the first part of the training session. During the second part of the training session, the Os were given practice in making judgments on the experimental conditions described below. During this part of the training session, the Os were not informed of the correctness of their judgments.

The experiment was run with a 2-in. and a 32-in. spatial separation between the lights. On each experimental day, the ISI was determined at which an O reported apparent motion disappeared with a stimulus separation of 2 in. These ISI values were always at least 150 msec less than the 450-msec ISI used in the experiment. The Os never reported the appearance of apparent movement with a separation of 32 in. For each spatial separation, there were four experimental conditions. In Condition A, the successive flashes of the two stimulus lights were presented, once in a left-to-right direction (adapting stimulus) and on the second presentation in the opposite direction (test stimulus) (1-1 in Table 2). In Condition B, the adapting stimulus was presented 10 times in a left-to-right direction and the test stimulus on the 11th presentation in the opposite direction (10-1). In Condition C, the adapting stimulus was presented once in the left-to-right direction and the test stimulus on the second presentation in the same direction (2-0). In Condition D, the adapting stimulus was presented 10 times in the left-to-right direction and the test stimulus on the 11th

presentation in the same direction (11-0). An O was instructed to judge whether the ISI between the successive lights of the test stimulus was greater or less than the ISI on the last presentation of the adapting stimulus, i.e., the first presentation in Conditions A and B and the 10th presentation in Conditions C and D. The E signaled the O before the 1st presentation in Conditions A and B and before the 10th presentation in Conditions C and D.

A trial consisted of a sequence of 2 stimulus presentations (Conditions A and C) or of 11 stimulus presentations (Conditions B and D). Four blocks of 20 trials were run on each of the 3 experimental days: two blocks with a spatial separation of 2 in. and two blocks with a spatial separation of 32 in. The trials consisting of 2 and 11 stimulus presentations were run in separate blocks. One block was composed of 18 trials consisting of 2 stimulus presentations, 9 trials each from Conditions A and C, and one block was composed of 18 trials consisting of 11 stimulus presentations, 9 trials each from Conditions B and D. Thus, in each block there were 9 trials in which the test stimulus was presented in the same direction as the adapting stimulus and 9 trials in which the test stimulus was presented in the opposite direction to that of the adapting stimulus. Two catch stimuli, in which the ISI between successive flashes of the test stimulus was 540 and 360 msec, were added to each block. On one of the catch trials, the test stimulus was presented in the same direction as the adapting stimulus, and on the other, the test stimulus was presented in the opposite direction.

Each O made a total of 27 judgments under each experimental condition. The order of presenting the 2- and 32-in. spatial separations was determined randomly for each O on each experimental day. For each spatial separation, the order of presenting the blocks of trials with 2 and 11 stimulus presentations was also determined randomly. The 20 trials within a block were also randomized separately for each O. A 20-sec interval separated the trials in a block. Two-minute rest periods were given Os between blocks and a 5-min rest between spatial separations. All Os were dark adapted for 5 min before the experiment began. The Os were instructed to fixate the red fixation light at all times. On each experimental day, the Os were given four practice judgments with the spatial separation to be presented first on that day.

Results

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Table 2
Means and Standard Deviations of the Number of Times the Test
Stimulus ISI was Judged Less in Experiment II

		Test Stimulus in Opposite Direction		Test Stimulus in Same Direction	
		Conditions			
		A	B	C	D
		2 Presen- tations (1-1)	11 Presen- tations (10-1)	2 Presen- tations (2-0)	11 Presen- tations (11-0)
2-in. Separation	Mean	12.9	18.5	15.6	11.3
	SD	3.5	2.8	2.9	1.8
32-in. Separation	Mean	13.9	12.3	14.4	12.3
	SD	1.5	1.8	2.9	1.8

of a neural mechanism resulting from repetitive stimulation would cause an O to judge the successive flashes of the test stimulus as occurring more quickly when the test stimulus was presented in the opposite direction following exposure to an adapting stimulus. The number of quicker succession judgments should, therefore, be greater in Condition B compared to Condition D, but not in Condition A compared to Condition C. The number of quicker judgments should also be greater in Condition B compared to Condition A, but not in Condition D compared to Condition C. The two latter comparisons are not independent of the earlier comparisons.

Table 2 presents the means and standard deviations of the number of times that the test stimulus ISI was judged to be less (out of 27) as a function of the experimental conditions. It is seen that the number of less judgments differed with a 2-in. separation, but not with a 32-in. separation. A four-way analysis of variance (Os by Direction of the Test Stimulus by Number of Presentations of the Adapting Stimulus by Spatial Separation) evaluated the overall effects of these factors. The analysis of variance revealed a significant Direction of the Test Stimulus by Number of Presentations of the Adapting Stimulus by Spatial Separation interaction [$F(1,7) = 19.0$, $p < .01$]. In order to compare the significance of the differences in the mean numbers of less judgments, a Tukey test of multiple comparisons was applied to the eight means in Table 2. With a 2-in. separation, the mean number of less judgments in Condition B, where the test stimulus was presented in the opposite direction following 10 adapting presentations, differed at the .01 level from the mean number of less judgments in Condition A, where the test stimulus followed one adapting presentation, and in Condition D, where the test stimulus was presented

in the same direction as the adapting stimulus.³None of the remaining experimental conditions differed significantly from each other. Statistical tests of the number of less judgments were also made against the expected chance level of 13.5 less judgments. Only the mean differences in Condition B [$t(7) = 4.4$, $p < .004$] and in Condition D [$t(7) = 3.0$, $p < .02$] with a 2-in. separation were significant.⁴ The probabilities of the mean differences in the remaining six conditions occurring by chance were each greater than .5.

The results indicate that an aftereffect was obtained with a 2-in. spatial separation when the stimulus conditions were such as not to produce the perception of apparent movement, and that no aftereffect was obtained with a spatial separation of 32 in. It is unclear why in Condition D, with a 2-in. separation, there was a tendency to judge the ISI of the test stimulus as less. One explanation is that, though the instructions emphasized that Os were to judge the test stimulus in comparison with the last presentation of the adapting stimulus, an O's judgments may have been influenced by the overall adaptation level determined by the preceding presentations of the adapting stimulus. If repetitive presentations of the adapting stimulus produced an increase in the apparent ISI because of fatiguing a neural mechanism sensitive to the temporal separation, judging the ISI of the test stimulus with respect to an adaptation-level ISI determined by the sequence of presentations would make it appear greater.

DISCUSSION

The results of the present experiments indicate an aftereffect of repetitive discrete stimulation that is determined by the direction of the two successive lights in the test stimulus to the direction of the lights in the adapting stimulus. The fact that it is direction specific suggests that it involves the desensitization of a

directional mechanism and is not the result of a general fatigue of neural receptors. The results also show that the aftereffect does not depend on the perception of apparent motion. Rather, the results suggest that the aftereffect is an inverse function of the spatial separation between the two stimuli. They therefore suggest the presence of neural structures for the discrimination of sequential changes in spatial position which are subject to adaptation and respond with decreased sensitivity to the presentation of the two lights in a spatial direction which has been recently strongly stimulated.

The theoretical significance of the present results is that the finding of an aftereffect suggests that the perception of apparent movement involves the excitation of a neural detector that declines with continuous stimulation. It has been recently argued that movement aftereffects support an explanation of the perception of real movement in terms of the excitation of a movement-detecting analyzer. The assumptions underlying the attribution of a movement aftereffect to the differential adaptation of a movement analyzer are outlined by Barlow and Hill (1963) and Sekuler and Pantle (1967). What is suggested is that the perception of apparent movement is not the result of the discrimination of a difference in the temporal or spatial localization of stimuli. That is, the perception of apparent movement is not, as suggested by Kinchla and Allen (1969), the result of an inference based on comparing the registered position of a stimulus at one point in time with the registered position of the stimulus at an earlier point in time. Rather, the perception of both real and apparent movement involves the stimulation of a specific detector that is sensitive to a sequential change in position. Thorson, Lange, and Biederman-Thorson (1969) have shown that the perception of movement in peripheral vision can be induced by sequentially flashing two stimuli which lie too close together to be resolved.

The suggestion that both real and apparent movement involve the stimulation of a movement analyzer does not, of course, mean that all phenomena attendant the perception of real movement occur in the perception of apparent movement. Differences may be expected because of the greater discreteness in stimulation in apparent movement. Kolers (1964), for example, has reported that a line in real movement decreases the detectability of a light in its path but that a line in apparent movement does not. We also do not wish to identify the perception of apparent movement solely with the

firing of a specific neural detector. The results of Experiment II, in which an aftereffect occurred without the perception of apparent movement, indicates that the firing of a sequential detector does not necessarily result in the perception of movement. Apparent movement involves many complex factors and may be influenced by the perceptual set of an O (Mandy-Van Moerbeke, 1967). Interpretative processes may also determine when dissimilar stimuli are presented, whether the perception of movement occurs in the plane or in three dimensions (Kolars & Pomerantz, 1971). Apparent movement may depend also on the phenomenal separation between stimuli rather than on the retinal separation between stimuli (Corbin, 1942). We, therefore, propose that the firing of a detector sensitive to sequential change needs to be integrated with the information about the form of an object and the spatial separation of an object in three-dimensional space to give rise to the perception of a continuous apparent movement. When a sequential detector is stimulated without such support, there may be a sense of movement without the perception of a continuous movement through the intervening space. This may also be the basis for Wertheimer's pure phi movement (1912), in which there is a sense of movement without reference to an object.

It should be noted that, though phenomenally there was no impression of movement with a 2-in. separation in Experiment II, the lights were perceived as having an influence on one another. It was as if the second light followed from the first light. Some Os described it as one light passing behind an object and then reemerging. This is similar to the functional relation between stimuli described by Michotte (1963). We would like to propose that this sense of a functional relation is the result of

the excitation of a sequential detector. It may be possible to investigate this subtle phenomenal distinction by having Os make temporal order judgments. What is suggested is that the temporal order of stimuli may be indicated in two ways: (1) the firing of a detector that is sensitive to sequential changes in spatial position, and (2) the discrimination of the temporal succession of two lights in terms of the asynchrony of their onsets and offsets. The results of Experiment II suggest that a sequential detector would be less effective in indicating temporal order for large spatial separations. Thus, the judgment of the temporal order of stimuli with small spatial separations may be facilitated because of a mechanism which generates a special signal correlated with their temporal order. It may be expected, therefore, that the discrimination of temporal order would become worse with the increasing spatial separation of two stimuli.

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NOTES

1. An analysis of variance applied to the untransformed data gave the same results.
2. If we test the three differences at the .01 level per comparison, the overall error rate per experiment is .03, i.e., the probability that one or more of the differences reported will be erroneous.
3. It should be noted that Condition B did not differ significantly from Condition C. This was due to one O whose judgments deviated markedly from those of the remaining Os. With a 2-in. spatial separation, this O, for example, judged the test stimulus ISI to be less 12 times in Condition B and less 20 times in Condition C. The pattern of her judgments suggested that this O had developed a response bias in which she judged the test stimulus ISI to be less with two stimulus presentation trials (Conditions A and C) irrespective of the test stimulus direction and the spatial separation between stimuli. Her judgments most strongly affected the means with a 2-in. spatial separation. Without this O, the mean and standard deviation in Condition A were 11.9 and 2.4, respectively; in Condition B, 19.4 and 1.4; in Condition C, 14.9 and 2.2; and in Condition D, 11.4 and 1.8. A Tukey test without this O showed that Condition B, with a 2-in. separation, differed from all other conditions at the .01 level.
4. The error rates reported are on a per comparison basis. If we test the eight differences at the .005 level per comparison, the overall error rate per experiment is .04, i.e., the probability that one or more of the differences reported will be erroneous. Condition B would still differ from chance, but Condition D would not with this more stringent error rate.

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