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# A reexamination of two-point induced movement

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Duncker's (1929) two-point induced movement phenomenon was reexamined to determine whether or not, as Duncker reports, the fixated stimulus is the one which is most likely to appear to move when objective stimulus movement is at or below subject-relative threshold. Data are reported indicating this is not the case.

In his paper concerning induced movement, Duncker (1929) describes a situation in which two luminous disks are viewed in an otherwise black field. One disk is moved slowly towards or away from the other disk, which remains stationary. The motion of the moving disk is described as "just liminal," i.e., motion which is just at or slightly above the subject-relative motion threshold.<sup>1</sup> Duncker states that when presented with this array, four out of the six observers reported that the disk on which they fixated appeared to move regardless of whether this point was or was not actually the moving one. He concludes from this that, "Other things being equal, there is a greater tendency for motion to appear in the fixated than in the non-fixated disc" (p. 165).

There are grounds for skepticism concerning this finding. If the movement is suprathreshold, as it seems to have been in Duncker's study,<sup>2</sup> then it is unclear why it should not be reliably detected, why the stimulus that is actually moving would not be the one perceived as moving. If, on the other hand, the objective movement is subthreshold, then the sole basis for motion perception becomes the changing location of one object relative to the other and there is no apparent reason why either the moving or the stationary disk, or, alternatively, the fixated or the nonfixated one, should appear to move more consistently than the other. Only if some principle of motion perception other than object-relative change is playing a role should there be a consistent tendency to see one or the other stimulus moving. At least by implication, Duncker does suggest that another principle is operative here which could account for the fact that the fixated disk is perceived to move significantly more often than the nonfixated one. The principle, if we may call it that, is that, under conditions in which motion is below threshold, that object appears to move which shifts its position relative to a frame of reference. If the nonfixated disk acts as frame of reference for the fixated one, then it follows that only the fixated one will appear to move. But in what sense is the nonfixated object a frame of

reference? The stimuli are of equal size. One is not surrounded by the other and these seem to be at least two characteristics of frames of reference, certainly as that term is used by Duncker. Moreover, if either disk were to serve as a frame of reference for the other, there is some reason to think that the fixated and not the nonfixated stimulus would play that role. Work of Johansson (1950) suggests that, in many dynamic stimulus configurations, if one of the stimulus points is fixated and tracked, it acts as a frame of reference for the other moving points. Since these configurations involve suprathreshold motion, it is, of course, not possible to generalize from them to a situation in which the motion is below threshold. On the other hand, Duncker describes the motion in his experiment as "just liminal," which suggests some conflict between Johansson's findings and his.

A further reason for skepticism concerning Duncker's findings is that if there is another basis for motion perception in this situation over and above relative displacement, it seems likely that this might involve the position constancy mechanism which matches observer movement information against retinal displacement information. If these two kinds of information match, an object is perceived as stationary. A mismatch signifies object movement. When there is two-point induced movement and the objective movement is below threshold, we can probably assume there is no retinal image displacement information or eye-movement information. For it is probable that if there were detectable image displacement, the objective stimulus motion would have to be suprathreshold. We can for this reason, also assume that there is *no* information that the eyes are moving, since, by instruction, they are fixating on either the physically stationary or moving stimulus. On the contrary, the information concerning the activity of the eyes must be that the eyes are stationary. Given information that the eyes are stationary and that the image of the object on which they are fixated is retinally stable, the fixated stimulus should appear stationary. The relative displacement should be attributed to the movement of the nonfixated stimulus and it should then be the one perceived as moving. It must be added, however, that

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there are no clear grounds for assuming that this mechanism is activated when stimulus motion is subthreshold. On the other hand, there is reason to believe that this mechanism is activated by suprathreshold motion, which is why we have argued that this provides a further reason for skepticism concerning Duncker's reported results.

The experiments reported were designed to examine the question of whether or not there is a consistent tendency to perceive the fixated or the nonfixated point moving when there is two-point induced movement and the physical movement is either below or just at the subject-relative motion threshold. Experiment I involved subthreshold movement.

## EXPERIMENT I

### Method

**Subjects.** Ten subjects were tested and paid for their services.

**Apparatus.** The stimuli consisted of two points of light displayed on a Tektronix 5103N oscilloscope with a fast phosphor (P31). The light points were located at eye level so that the midpoint between them was aligned with the subject's sagittal plane. The initial separation between the points was 18 mm (2.54°). They were viewed through a sheet of smoked Plexiglas placed in front of the oscilloscope screen, which served to block any glow from the screen itself and thus insured that the points were viewed in a completely black field. Both the subject and the oscilloscope were housed in a light-tight unit. The motion of the points was produced by a ramp wave form effected by a Wavetek (Model 116) function generator operating in a triggered mode which acted through a Tektronix Type 4701 multiplexer. The subject's eyes were at a distance of 40.6 cm from the screen and his head position was maintained by a bite plate.

**Procedure.** Each presentation of the stimuli was preceded by the experimenter's saying "ready" and an audible click, at which point the two stimuli appeared. The stimuli remained stationary for an interval of 2 sec, at the end of which a second audible click signaled the onset of stimulus movement. One of the points then moved laterally at a speed of 7.62"/sec for 2 sec either towards or away from the other point, which remained stationary. Then the stimuli disappeared and the visual field became completely dark. The 2-sec intervals were regulated by a Hunter Type 100c electronic interval-timer. The subject indicated which point appeared to move and the direction of its movement by manipulating either to the left or right one of two telephone-type, double-throw switches, one of which was located to his left and the other to his right. These switches generated a signal on a display board visible only to the experimenter.

In order to verify that a stimulus movement of 7.62"/sec for 2 sec was in fact below the subject-relative threshold for all subjects, the following procedure was used: Each subject was presented, prior to the two-point testing, with a single light point, located straight ahead on the screen, which remained stationary for 2 sec and then moved left or right at 7.62"/sec for 2 sec or remained stationary for an additional 2 sec. A forced-choice procedure was used. The subject indicated whether the point had moved to the left or right. In all instances, the subjects' reports were random, confirming that the motion was, in fact, clearly below threshold.

Following this preliminary procedure, the subjects were instructed in the use of the indicator switches and were told, "In each of the following trials two points will appear. You will be instructed to fixate on either the left or the right one. After 2 sec you will hear a click which will signal that one of the two points has

begun to move either left or right. Wait until the points have vanished and then signal to me which point moved and the direction of its movement. In addition, I would like you to call out the number 1, 2, or 3 to indicate how confident you are in the report you have given." The subjects were told that a report of 1 should accompany judgments about which they felt sure and a report of 3 should accompany those they felt were guesses. They were also told that if both points appeared to move, they should arbitrarily report the movement of only one accompanied by a confidence rating of 3 and the word "both." The subjects were given a total of 100 trials. There were 20 trials for each of the four possible motion conditions: left point-left, left point-right, right point-left, and right point-right, plus an additional 20 trials in which neither point moved. For 50 of the 100 trials, the subject fixated the left point and for 50 trials, the right point. Within each of the blocks of 50 trials, both the direction of movement and which point moved were randomized, with the restriction that no particular motion condition occurred more than twice in a row. Subjects always fixated on either the left or right point for 10 consecutive trials.

### Results

Since the question that interests us is whether or not there is a consistent tendency among subjects to perceive the fixated or nonfixated point as moving, the data were examined in terms of the number of movement reports indicating that either the fixated or the nonfixated one appeared to move. If, for the moment, we exclude the no-movement trials, the nonfixated point was reported to move on 508 of the 800 trials (64%). Conversely, the fixated point was reported to move on 292, or 36%, of the trials. The mean confidence rating for these reports were essentially equal, 1.66 and 1.58, respectively. Thus far it seems clear that Duncker's findings have not been confirmed. When the objective movement is distinctly below threshold, the nonfixated point is reported as moving considerably more than twice as often as the fixated one. It is interesting to note that whereas only 395, or fewer than half, of these reports were actually veridical, 741, or nearly all, of the reports were veridical if one considers only the object-relative aspect of the motion. Subjects rarely reported that the left point moved left when the right point moved left or the left point moved right, although they frequently reported that the left point moved left when in fact the right point moved right, and vice versa.

If there were no other appropriate way of dichotomizing the data than in terms of whether the fixated or nonfixated stimulus was reported to move, one might be tempted to conclude that either the fixated point tended to act as a frame of reference or that the mechanism evaluating image movement in terms of eye-movement information was operative. But no such conclusion is defensible, since the data must also be examined in terms of whether there is a clear tendency to perceive either the right or left point as moving, regardless of which one is fixated. Looked at in this way, the data reveals that 58% of all reports were that the right point moved regardless of which was fixated. Thus, the right point appeared to move more frequently than the fixated one. Of the 10

subjects tested, 4 reported that the nonfixated point moved on 76 or more of the 80 trials in which one point actually did move, and 1 subject reported that the nonfixated point moved on 60 of these 80 trials. Two subjects tended to perceive the fixated point moving. One did so on 78 and 1 on 62 of these 80 trials. Two subjects had a clear tendency to report that the right point moved. One did so on 73 and 1 on 66 of these 80 trials. The 1 remaining subject showed no consistent response tendency. For all but 2 subjects, the tendency to perceive the fixated, nonfixated, or right point moving was also apparent on the 20 no-movement trials. In fact, 4 of the 5 subjects who tended to report that the nonfixated point moved and 1 subject who consistently reported that the fixated point moved did so on 20 out of the 20 no-movement trials. The change in confidence ratings in these trials ( $\bar{X} = 2.63$ ) does indicate, however, that subjects were much less sure of these reports.

Thus, while there is a tendency for the majority of the subjects tested to report that the nonfixated point moved more often than the fixated one, the data seems best described as reflecting idiosyncratic subject biases in a situation in which the basis for motion perception is strictly object-relative displacement.

There are at least two reasons which may explain why our findings differ from Duncker's. (1) We used a stimulus motion that was clearly below threshold, whereas Duncker describes the stimulus motion in his experiment as "just liminal," indicating that it was slightly above threshold.<sup>2</sup> (2) Since there are clear differences between subjects in their patterns of response, it is possible that by chance we tested a group of subjects whose patterns of response were different from those Duncker tested.

On the chance that the differences between our results and those reported by Duncker were a function of the difference in the rate of stimulus movement, we tested four subjects using a movement speed of  $1^\circ/\text{sec}$  for 2 sec. This was the same speed as that used by Duncker, although our motion interval was shorter, 2 sec as compared to Duncker's 8 sec. The procedure was identical to that described above. Out of 320 movement trials (80 per subject), there were only seven objectively nonveridical reports; i.e., regardless of which point was fixated, the subjects correctly reported that the point which actually moved appeared to move. This is not surprising given the fact that the movement was well above threshold. This, therefore, cannot be the source of the difference in results and, in fact, it makes Duncker's findings the more puzzling.<sup>3</sup>

Since Duncker describes the stimulus movement in his experiment as "just liminal," a description difficult to understand in view of the fact that his stimulus moved at a rate of  $1^\circ/\text{sec}$ , it seemed reasonable to repeat Experiment I, using a movement

speed that was empirically determined to be "just liminal." This would make it possible to determine whether a just-liminal motion would yield results like those Duncker reports.

## EXPERIMENT II

### Method

**Subjects.** Ten subjects were tested and again paid for participation.

**Apparatus and Procedure.** The apparatus and procedure were the same as in Experiment I, with the exception that the following procedure was used to determine each subject's subject-relative-motion threshold. Prior to the two-point testing, the subject was presented with a single light point straight ahead on the screen. This point remained stationary for 2 sec, an audible click sounded and the point moved left or right for 2 sec. For the first 25 trials, the point moved at  $22.86'/\text{sec}$ . Subjects reported whether the point moved left or right. All 10 subjects gave completely veridical reports on all 25 of these trials. On the next block of 50 trials, the point moved at  $15.24'/\text{sec}$ . If a subject's report was less than 75% veridical, successive blocks of 50 trials were run with increasingly faster rates of movement. If a subject's report was more than 75% veridical, successive blocks of 50 trials with decreasing rates of stimulus movement were run. Movement rate was increased or decreased by  $1.25'/\text{sec}$  steps until the 75% criterion was met.

Once having established threshold in this way, two-point testing was begun. For each subject, the rate of stimulus movement was that which had been determined to be his or her threshold speed.

### Results

Threshold speeds ranged from  $8.89'/\text{sec}$  to  $16.5'/\text{sec}$ .<sup>4</sup> The mean threshold was  $13.21'/\text{sec}$ , which agrees rather closely with the figure of  $12.18'/\text{sec}$  which Brown and Conklin (1954) report as the mean subject-relative-motion threshold for a 1.97-sec movement interval. Excluding the no-motion trials, 52% of the reports were that the nonfixated point moved and 53% of the reports were that the right point moved regardless of which was actually fixated. Four subjects had a tendency to report that the nonfixated point moved: one on 79, one on 70, one on 58, and one on 52 of the 80 movement trials. Three subjects had a tendency to report that the fixated point moved: one on 80, one on 73, and one on 60 of the 80 movement trials. One subject tended to see the left point moving and did so on 65 of the 80 movement trials. The remaining two subjects showed no single response pattern. Fifty-six percent of all movement reports were veridical, which is an increase of 7% over Experiment I, and 98.5% of all reports were veridical in terms of the object-relative character of the movement.

## DISCUSSION

These results, like those of Experiment I, fail to confirm Duncker's findings, and, again like those results, suggest that when the single or strongest determinant of motion perception is relative displacement and there is no clear frame of reference,

a subject's perception that one or the other stimulus is moving seems to be a function of an unexplained idiosyncratic bias. That this is the case when the objective stimulus motion is "just liminal" (Experiment II) as well as when it is below threshold (Experiment I) suggests the priority of relative displacement as a basis for motion perception. Apparently, it successfully dominates simple image displacement even when image displacement occurs at a clearly detectable rate (Experiment II). That this is the case provides further grounds for rejecting the view that receptor units uniquely responsive to motion in a particular direction across the retina are the basis for the perception of motion. When stimulus motion is below threshold, simple image displacement is not detectable, but there is object-relative displacement and motion is readily perceived. Even when the stimulus motion is detectable, the perceived motion is not determined by simple image displacement. Therefore, one is forced to conclude that whatever function motion detectors play in perception, they cannot account for the perception of motion in these experiments or indeed in any situation in which induced movement occurs.

Finally, our data lead us to conclude that Duncker's report that with two-point induced movement the fixated disk is more likely to be seen as moving than is the nonfixated one is simply wrong. However, it must be noted that Duncker's important distinction concerning the two modes of stimulation which give rise to perceived motion, object-relative and subject-relative displacement, is fully supported by our data.

#### REFERENCES

- BROWN, R. H., & CONKLIN, J. E. The lower threshold of visible movement as a function of exposure-time. *American Journal of Psychology*, 1954, 67, 104-110.
- DUNCKER, K. Induced motion (1929). In W. D. Ellis (Ed.), *A source book of Gestalt psychology*. London: Paul, Trench, & Trubner, 1938. Pp. 1961-1966.
- JOHANSSON, G. *Configurations in event perception*. Uppsala: Almqvist & Weksell, 1950.
- SHAFFER, O., & WALLACH, H. Extent-of-motion thresholds under subject-relative and object-relative conditions. *Perception & Psychophysics*, 1966, 1, 447-451.

#### NOTES

1. Subject-relative motion is defined as motion relative to the observer and is distinguished from object-relative motion which is motion of one object in the visual field with respect to another. The threshold for subject-relative motion is known to be considerably higher than that for object-relative motion (Shaffer & Wallach, 1966).

2. We calculated from Duncker's figures that his stimuli moved at 1° sec for 8 sec, which we found to be well above the subject-relative threshold.

3. A variation of Experiment I in which six subjects were tested yielded essentially identical results. In this version, 50 of the 100 trials given each subject were like 50 of the trials in Experiment I: one point moved left or right or neither point moved. Of the remaining 50 trials, there were 40 in which both stimuli moved either together or apart and 10 in which both moved left or right. The trials of interest are those 40 in which both stimuli moved towards or away from each other, where the object-relative displacement was doubled with no increase in subject-relative displacement. Subjects again had to report movement of only 1 point. Of the total 240 trials in which the points moved together or apart, 142 yielded reports that the nonfixated point moved and 98 yielded reports that the fixated point moved. Analyzing only these trials, three subjects showed a clear tendency to see the nonfixated, two the fixated, and one the left point moving. These results are not significantly changed if a similar analysis is carried out on all 100 trials. Thus, even where the object-relative displacement is doubled, we failed to obtain Duncker's results and continued to obtain results indicating that there is, if anything, a dominant tendency to perceive the nonfixated stimulus as moving.

4. This finding further confirms the fact that the stimulus motion in Experiment I was below the subject-relative threshold for all subjects.

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