"Subliminal cues" and the Müller-type illusion[1]

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Using the viewing box from a 2-field tachistoscope, feathers-arrows from 1 field were superimposed upon line-pairs from the other field to construct the Muller-Lyer illusion. 6 Os were tested for the illusory effects under 4 conditions of feather-arrow detectability: (a) d'=0, (no luminance); (b) d'=.42; (c) d'=1.00; and (d) d'=3.7. The length differences of lines of any given pair were 0 in., 1/64 in., 2/64 in., or 6/64 in. The illusion effect was observed when the feather-arrow d' equaled 3.7. No significant nor suggestive illusion effects were found for the other feather-arrow detectability conditions.

In 1900 Dunlap reported an experiment in which the feathers and arrows used to produce the Müller-Lyer illusion were projected at imperceptible or just barely perceptible levels. There was some indication that the illusion effect was obtained by his Os in the absence of their being conscious of the presence of the distorting feathers and arrows. Dunlap, however, considered his apparatus too imprecise to state anything conclusive from the results obtained from it. In a replication of Dunlap's work, Titchner and Pyle (1907) found no significant results but Bressler (1931) in a further investigation of the problem concluded that his Os got the illusory effect even though the feathers and arrows were presented "subliminally."

Since these pioneering studies Es have shown considerable ingenuity in devising other experimental tasks or judgments for demonstrating the subtle effects of "subliminal cues" (see Eriksen, 1961, for a summary of these studies). Most recently a series of experiments supposedly has demonstrated the effects of "subliminal stimuli" in establishing anchoring effects or adaptation level for the judgments of supraliminal shock intensity (Black & Bevan, 1960, size judgments (Boardman & Goldstone, 1962) and the judgment of loudness of tones (Bevan & Pritchard, 1963).

Unfortunately these recent experiments have not availed themselves of modern indicator methodology and sophistication regarding the meaning of thresholds and as a consequence have not contributed to resolving the controversy that surrounded the older studies. Blackwell's (1953) classic work on forced-choice indicators has shown that the traditional psychophysical methods can seriously underestimate the sensitivity of the O and the work of Egan (1958), Egan and Clarke (1956), and Tanner and Swets (1954) with concepts derived from the theory of signal detection have provided powerful techniques for obtaining sensitivity measures from the O that are at least relatively free from his subjective criterion. The traditional psychophysical methods seriously confound the O's sensitivity to stimuli with his criterion for reporting their occurrence. Differences in "thresholds" between individuals can be due solely to these criterion differences, not to sensitivity, and stimulus energy levels that are "subliminal" can be found to be liminal when the differential costs of false alarms and missed signals are changed or the O is instructed to assume a more liberal criterion (Swets, Tanner, & Birdsall, 1961).

The term "subliminal" would seemed to have outlived any usefulness it ever had in psychology. Not only is there a real question as to the existence of limens (Swets, 1961) but the definition is unique to each E who employs the term and his particular psychophysical methodology. While it has reader interest this is almost solely due to its extensive surplus meaning derived in a large part from the Freudian theory of the unconscious. When the surplus meaning of the concept is contrasted with the specific defining operations of the term in a particular experiment and the latter is evaluated in terms of modern indicator methodology (Eriksen, 1958; Goldiamond, 1958), the lack of value of the concept would seem to be evident.

There is one sense in which this research area could provide a methodologically sound contribution. Instead of attempting to demonstrate via an experiment that stimuli defined by some nebulous criteria as "subliminal" are capable of influencing other behaviors, the research could be oriented to defining the functional relation between intensity of cues and their effect upon another judgmental task or behavior. For the Müller-Lyer illusions we could ask the question as to how much of an illusion effect is obtained as the feather and arrow cues are systematically reduced in intensity. To be maximally meaningful the cue intensity dimension should be scaled in terms of a sensitivity or detection measure that is not confounded with the O's subjective criterion.

In the present experiment we have re-examined the effect of low intensity cues on the Müller-Lyer illusion. The detectability of the feather-arrow cues was determined for each O with the d' statistic (Egan & Clarke, 1966) as the sensitivity measure. The values of d' for the feather-arrow cues were varied over the range of .4 to 3.7 and the effect upon the O's ability to judge which one of a pair of lines was longer was noted at each d' value.

METHOD

Observers. A total of 30 Os was used for various phases of the experiment. All were undergraduate males who were obtained as volunteers from an elementary psychology course at the University of Illinois.

Apparatus and stimulus materials. The basic apparatus was a viewing box from a two-field tachistoscope. The two parallel lines of the Müller-Lyer figures could be placed in one stimulus field of the tachistoscope and in the other the feathers and arrows necessary for the production of the illusion. Through careful construction of the stimulus materials the feathers and/or arrows superimposed on the termination of the two parallel lines and from the O's point of regard he saw a single figure, namely the Müller-Lyer illusion. For this experiment the regular tachistoscope lamps were replaced by incandescent lamps. The line stimulus field contained a constant luminance and the feather-arrow stimulus field varied experimentally from no luminance to a luminance value where the feathers and arrows were clearly detectable. This luminance variation was obtained via a variac and a constant voltage power supply. During a trial both stimulus fields were activated simultaneously and terminated after 2 sec. by Hunter timers.

For the line stimulus field eight cards were constructed each having two parallel vertical lines 1 in. apart. The left line was always 3/4 in. higher than the right line. On four of the cards the left line was 2 in. long and the right line was either 2 in., 2-1/64 in., 2-2/64 in., or 2-6/64 in. On the other four line cards the situation was reversed. That is, the right line of the pair was constant at 2 in. while the left line assumed one of the other four values.

Sixteen stimulus cards were needed for the feather-arrow stimulus field. Each of these cards contained the Müller-Lyer feathers-arrows constructed so as to superimpose on one of the sets of parallel lines. For eight of the cards the feather-arrow arrangement was designed to produce the illusion in which the right line would appear to be the longest and the remaining eight produce the illusion in the opposite direction.

In addition to these experimental stimuli, materials also were necessary to determine the detectability of the feathers-arrows at different luminance levels. For this purpose the line stimulus field contained a stimulus card having two dots 1 in. apart horizontally. For the feather-arrow field two stimulus cards were constructed. On one of these a feather was placed so that its image was superimposed over the image of the left dot and on the other card superimposed over the right dot.

For all stimuli the feathers-arrows and lines were drawn in India ink on white plastic cards. The feathers were drawn at angles of 150° and the arrows of 30° to the lines and were 5/32 in. long beginning 1/16 in. from the vertex of the angle.

Procedure. Six Os were used in a pilot study to determine general luminance ranges where the detection of the feathers-arrows would be in the region yielding d' values of 0 to .5; .75 to 1.25; and 3.5 to 3.7.

Twenty-four Os were pretested on luminance values obtained from the pilot study. During the pretesting each O made 60 judgments at each of three luminance levels as to whether the feathers appeared above the right or the left dot. In addition to choosing right or left on each trial O also gave a confidence judgment of 1, 2 or 3 which reflected how certain he was of his judgment. In the second session the parallel vertical line pairs were presented to O for judgment. Sixty judgments as to which was the longest line were obtained for each length difference (1/64, 2/64, and 6/64 in. difference). On the basis of the pretest data six Os from the 24 were selected who showed comparable line length discrimination and comparable sensitivity in detecting the feathers at the different luminance values. For some Os it was necessary to interpolate from the pretest performance in order to find luminances appropriate for the desired d's.

During the experiment proper the six selected Os served for three experimental sessions, during each of which they made 192 judgments. These judgments were distributed evenly among the 16 experimental conditions. obtained from the four line length differences (0, 1/64, 2/64, and 6/64 in.) and four luminance levels for the feather-arrow stimulus field (no luminance and luminance levels selected for each O yielding d's of .4, 1.0, and 3.7). The luminance of the line stimulus field was always constant at 2.0 mL and the luminance values for the feather-arrow field varied from no luminance through the ranges for individual Os of .05 to .11 mL where d' = .4; from .10 to .15 mL where d' = 1.0; and 55 mL for all Os for the 3.7 d' condition.

The order of occurrence of the 16 experimental conditions was counterbalanced across and within Os and experimental sessions. The Os were asked to judge which line appeared the longest by responding right or left and to give an associated confidence rating of 1, 2 or 3, which corresponded to very sure, think so, or guess. On the 75% of the trials where one line was actually longer than the other the feathers-arrows were arranged so that half the time the illusion would reinforce the actual line difference and the other half to counteract it. Also O was thus unable to use the presence of the feathers or arrows when they were detectable as a cue as to which line should be called longer. On the 25% of the trials where the lines were of equal length, the occurrence of feathers and arrows was again evenly divided among the right and the left line.

RESULTS

Since the six Os had been selected for homogeneity in their sensitivity to line length discrimination and the luminance values used in the experimental sessions had been determined for each O to yield the selected d' values for feather-arrow detection, the data for the six Os were pooled in the following analysis. Sensitivity to the illusion was computed in terms of the d' statistic for each of the four feather-arrow detectability levels. In computing the sensitivity to the illusion a response

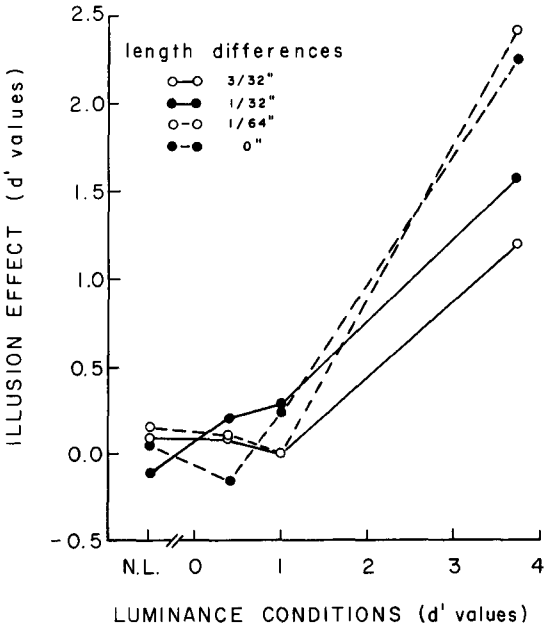

Fig. 1. Illusion effect for different line differences as a function of the detectability of the feathers-arrows.

calling the feathered line as longer was scored as a hit irrespective of the actual line length difference. For the no luminance condition where no feathers-arrows were presented superimposed on the lines, an arbitrary predetermined order of "correct" responses was employed in computing the d' for this condition.

In Fig. 1 sensitivity to the illusion in terms of d' is plotted as a function of the detectability of the feather-arrow stimuli. The parameters in Fig. 1 are for the four different line length differences. As can be seen, there is no consistent evidence across line length differences for the effect of the illusion when the feathers-arrows have a detection of d'=1 or less. However, there is convincing evidence that this particular experimental arrangement is capable of producing the illusion when the feathers-arrows are readily detectable. At a detectability level of d'=3.7, the illusion is present for all four line length differences. As is to be expected the illusion is greatest when the lines are equal in length or differ only by 1/64 of an inch. The illusion effect is proportionally less as the actual line length difference is greater. This of course results from the fact that on half of the trials the illusion has to counteract the actual line length difference.

To provide another test as to whether any illusion effects were present when the feathers-arrows had a detectability corresponding to a d' of 1 or less the following analysis was carried out. The number of times each O responded in the direction of the illusion for feather-arrow detectability of "no luminance," d'=.4 and d'=1.0, was subjected to a three-way classification analysis of variance (feather detectability, line length difference, and Os). None of the main effects including that of Os nor any of the interactions approached significance at even the $p < .10$ level.

DISCUSSION

It is unfortunate that our detection values for the feather-arrow cues did not include d's in the range between 1 and 3.7. As a result of these missing values the shape of the functional relation between cue detectability and its influence on judgment of length is in doubt. However, the results are clear-cut in showing no effect when the detection of the cues has a d' value of 1 or less.

While the conclusions to be drawn from the present experiment are quite at variance from the conclusions of Bressler (1931) and Bevan and Pritchard (1963), the experimental results are not necessarily discrepant. Bressler based his conclusion of subliminal influences of the cues upon the finding that most Os when asked postexperimentally to draw the stimuli they had seen, did not include the feathers and arrows in their drawings. When his Os were asked to detect the presence of his cue stimuli independent of the illusion, it was found that they could detect at better than 50% accuracy.

This lack of rigor in assessing limens is typical of studies on the effects of subliminal cues or stimuli. Bevan and Pritchard (1963) were content to rely on asking the Os after the experiment whether they had noted or observed the "subliminal" stimuli. Assessing O's awareness requires the same care in distinguishing between his experience and his subjective criterion for reporting that experience that is employed in establishing sensory detection functions. Assessing O's awareness with respect to various cues after the main experiment is over shifts the relative cost for yes versus no responses in the direction of a very conservative criterion for saying yes. Most Os are perceptive enough to realize that the E probably prefers that they hadn't noticed the cues and further, if they do say yes, there will be a burden of answering or explaining further. Under these circumstances the O is most apt to adopt a conservative criterion leading to his saying no unless he is very certain he recalls experiencing the subliminally designated cues.

Even if more rigorous attention is devoted to assessing the O's limen, a method of limits yielding a 50% threshold would most likely yield a stimulus intensity whose d' value would be in excess of 1. For example, if conservative practiced Os were used whose false alarm rates were 10%, a 50% hit rate under these circumstances would correspond to a d' of approximately 1.3. While the present data do not provide information on the effects of cues in this detectability range, it is not unlikely that at this intensity level they could be expected to exert some effect upon judgment.

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Note

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