Perceptual isolation effects: Short-term visual storage vs cognitive-perceptual structure¹

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Two hypotheses concerning the effects of perceptual isolation were examined. Three experimental groups were defined by the interval between the first and second stimulus presentations within a recognition-discrimination problem. Ninety Ss were exposed to 12 recognition-discrimination problems for each of three physical dimensions of random forms, both before and after ½ h of perceptual isolation. Analyses of the number of correct responses indicated support for the hypothesis that isolation increases the duration of the short-term visual storage, but not for the hypothesis that isolation produces change in the hierarchy of physical dimensions to which Ss selectively attend.

Despite the epidemic of demonstrations since Heron et al (1953) hypothesized that varied sensory input was required for maintaining normal cognitive, motivational, and perceptual behavior, few investigators have shed light on the specific nature of the behavioral changes occurring as a consequence of perceptual isolation (Siprelle et al, 1963; Brownfield, 1964). The procedure of perceptual isolation is distinguished from that of sensory deprivation in that stimulation in the former is invariant, boring, and monotonous, while in sensory deprivation stimulation is absent or markedly reduced (Kubzansky, 1961). Hallucinations have been reported both after prolonged isolation (Bexton et al, 1954; Zuckerman et al, 1962) and after short periods of perceptual isolation (Cohen et al, 1959; Silverman et al, 1962; Reed & Kenna, 1964). One explanation of these reports of hallucinations postulated by Freedman (1961) was that, because isolation provides no useful information for spatial orientation, an active process interferes with and degrades existing schemata so that the system is dominated by a "noisy" discharge of retinal ganglion cells. This is assumed to be disorienting and distorts the perceptual process. Other studies (Held & White, 1959; Freedman & Held, 1960; Zubek et al, 1963; Nagatsuka & Maruyama, 1963; Zubek et al, 1964; Nagatsuka & Suzuki, 1964; Suzuki et al, 1966) have investigated specific cognitive and perceptual behaviors. Nagatsuka (1965)

concluded that, while results of several studies demonstrated deteriorating effects on higher-order functions, there were facilitating effects on the lower-order ones. Similarly, Vernon and McGill (1961) and Hebb (1968) posited that perceptual isolation results in a reduction in the inhibition of input. The purpose of this study was to explore two possible explanations for the behavioral changes following perceptual isolation: (1) that there is a longer duration of what Haber (1969) refers to as "short-term visual storage," and (2) that there is a change in the hierarchical order of physical dimensions to which an individual selectively attends in the perceptual process (Forsyth & Brown, 1967).

Averbach and Sperling (1961) estimated that short-term visual storage is 270 msec. Mackworth (1963) estimated that this direct representation of information without verbal encoding may last a second or two under ideal conditions. Posner (1967) indicated the acceptance in the literature of this concept of representational storage. Hebb (1968) suggested that longer-duration visual storage results from more excitable first-order cell assemblies and posited that this increased sensitivity would explain some of the reported effects of perceptual isolation. Thus, one hypothesis tested in the present study was that perceptual isolation would extend the duration of the short-term visual storage. The second hypothesis tested in this study was that isolation alters the cognitive perceptual structure, or the hierarchy of physical dimensions to which the S selectively attends. Forsyth and Brown (1967) presented evidence supporting a perceptual selective-attention process, where a tachistoscopic procedure was used to determine the degree to which specific physical dimensions were used in selective perceptual attention. The results of that study demonstrated differential utility for three physical dimensions: compactness, jaggedness, and areal asymmetry. Forsyth and Brown (1968) reported that exposure to recognition-discrimination problems designed to emphasize metron variability on specific physical dimensions will affect the hierarchy of dimensions to which S selectively attends. If individuals

continuously sample their perceptual environments for reaffirmation of existing schemata and evidence for change (Freedman, 1961; Brownfield, 1964), it may be hypothesized that perceptual isolation will alter the individual's cognitive-perceptual structure such that he will attend less to physical stimulus dimensions which were high in the hierarchy of dimensions attended to before isolation.

METHOD

Subjects

Ninety undergraduate students enrolled in introductory psychology served as Ss in this experiment.

Materials

Stimuli were selected from a sample of 200 four-sided forms generated from the stimulus domain suggested by Attneave and Arnoult's Method 1 (1956) and described in detail by Brown and Owen (1967). Forms were selected so that 12 recognition-discrimination problems could be constructed for each of three physical dimensions. Each problem consisted of two pictures, one a single form and the other that same form paired with another form. The single form was selected to rank high on the selected dimension and was paired with a form that ranked low on the dimension. The definition of the form as high or low in rank on a given dimension was based upon the rank ordering of factor scores of 200 forms on the physical dimension under consideration. The three stimulus dimensions studied were "x-axis areal asymmetry" (D₁), "compactness" (D₂), and "jaggedness" (D₃). These dimensions have been described by Forsyth and Brown (1967) and Brown and Owen (1967).

The three channels of a Scientific Prototype tachistoscope were used to present the single stimulus, a controlled interval of 300, 750, or 3,000 msec, and the paired stimuli. The same tachistoscope was used as the viewing chamber during the ½ h of perceptual isolation.

Design

Three groups of Ss were assigned randomly to three conditions based upon the interval between the presentation of

Table 1
Mean Number of Correct Responses

Interval	Pre			Post		
	D ₁	D ₂	D ₃	D ₁	D ₂	D ₃
300	5.80	9.07	8.50	5.93	8.60	7.87
750	6.17	8.77	7.77	6.83	9.10	8.60
3000	5.00	6.93	8.40	4.73	7.20	8.53

the single stimulus and the paired stimuli in the recognition-discrimination problems. The intervals were 300, 750, and 3,000 msec. Each S was exposed to 12 recognition-discrimination problems for each of the three physical dimensions, both before and after the ½ h of perceptual isolation. Thus, the complete experimental design consisted of three factors varied at three, three, and two levels, respectively, with repeated measures on the three-level dimension factor and the two-level time factor. There were no repeated measures on the three-level interval factor.

Procedure

Following the presentation of tape-recorded instructions, S was given 10 practice trials with the tachistoscope, using curvilinear forms. A single trial consisted of presenting a single form for a duration of 6 msec, then a blank interval of 300, 750, or 3,000 msec, followed by a presentation of the paired forms for 3 sec. The interval between the presentation of the single form and that of the two forms was the same as the one used for any given S in the actual testing sessions. The 6-msec duration of the single form represented the average threshold for pilot recognition-discrimination problems. S's task was to respond with the side on which the previously shown form appeared. If S did not know which form had appeared alone, the answer "no" was to be given. Following the practice trials, each S was tested on the 36 test problems. The order of presentation was randomized.

At the end of Trial 36, Ss were instructed to look at the plain white screen

in the tachistoscope and count the number of times a flash of light appeared there. The Ss were exposed to white noise, wore restraining mittens, and were instructed to sit perfectly still and not talk throughout the "vigilance task." No information was given concerning the duration of the isolation period. Two flashes of light were superimposed on the screen, the first after 5 min and the second after 10 min of isolation.

Following the ½ h of isolation, Ss were again given the 36 recognition-discrimination problems using the same order of presentation as in the pre-isolation testing session.

RESULTS

Table 1 presents the mean number of correct responses for each treatment condition. Results of an analysis of variance are summarized in Table 2. The significant dimension main effect ($p < .01$) reflects the higher mean number correct on the compactness and jaggedness dimensions (8.28) than on the x-axis areal-asymmetry dimension (5.74). The significant Interval by Dimension interaction ($p < .05$) qualifies the dimension effect. Tests of simple main effects and the Newman-Keuls procedure showed that performance on the compactness- and jaggedness-dimension problems was superior to that on the x-axis areal-asymmetry problems for all intervals. The mean number correct on the jaggedness-dimension problems was significantly higher than on the compactness problems only for the 3,000-msec interval.

Figure 1 presents the significant Time by

Fig. 1. Mean number correct for each experimental group before and after perceptual isolation.

Interval interaction. A test of simple main effects on differences between pre- and postisolation performances for each interval group showed a significant increase in number of correct after isolation only for the 750-msec interval. Neither the Time by Dimension interaction nor the Time by Dimension by Interval interaction was significant.

DISCUSSION

The significant increase in mean number correct following perceptual isolation for the 750-msec-interval group confirms the first hypothesis that perceptual isolation extends the duration of the short-term visual storage. Since Averbach and Sperling (1961) suggested that the visual image lasts approximately 300 msec, Ss were expected to perform best under the 300-msec-interval, next best under the 750-msec-interval, and poorest under the 3,000-msec-interval condition before isolation. Although this order was obtained, the difference between the 300- and 750-msec groups before isolation was not significant. Thus, decay time for the storage before isolation was probably more than 300 msec for the stimulus domain used in the present study. It was assumed that, with less inhibition of input after isolation, the duration of the visual storage would increase, thereby permitting more time to read information directly from that storage under the 750-msec condition. A replication of this study, with a greater number of intervals, is demanded to determine the normal visual storage time for this stimulus domain and the quantitative specification of the change in this storage time as a function of different periods of perceptual isolation.

Support for the second hypothesis, that perceptual isolation would produce a change in the cognitive-perceptual structure, would have been obtained through a significant interaction between the dimension and time variables. That is,

Table 2
Analysis of Variance for Number Correct

Source	df	MS	F
Between Subjects	89		
Interval (I)	2	56.84	2.95
Ss within groups	87	19.27	
Within Subjects	450		
Dimensions (D)	2	385.06	45.19**
D x I	4	25.80	3.03*
D x Ss within groups	174	8.52	
Time (T)	1	1.67	0.54
T x I	2	9.94	3.21*
T x Ss within groups	87	3.10	
D x T	2	.20	0.08
D x T x I	4	2.18	0.90
D x T x Ss within groups	174	2.42	

* F value significant at the .05 level

** F value significant at the .01 level

if isolation produces a change in the utility of various dimensions for perceptual discrimination, and the three dimensions used in this study changed differentially in utility, an improvement in performance following isolation would have been noted for those dimensions moving higher in the hierarchy of dimensions selectively attended to and a decrement in performance on the dimensions moving lower in the hierarchy of dimensions to which Ss selectively attend. Because the first dimension had previously been shown not to be useful and the second two dimensions useful under nonisolation conditions (Forsyth & Brown, 1967, 1968), the expectation was that the second two might show a decrement in utility and perhaps the first dimension an increment in utility following isolation. The results indicated no Dimension by Time interaction, and an examination of the means for each type of problem showed virtually no relative change in utility from pre- to postisolation conditions. If perceptual isolation does produce a change in the cognitive-perceptual structure or hierarchy of dimensions to which Ss selectively attend, these dimensions apparently remain unaffected.

The findings of the present study are consistent with those of Goldberger (1961) and with the theoretical formulations concerning imagery by Hebb (1968). The results of tests of cognitive and perceptual functions in the McGill isolation studies (Brownfield, 1965), such as two-point limens, spatial orientation, the Kohs Block Test, Digit Symbol Substitution, mirror drawing, autokinetic effect, and movement afterimage, along with the perceptual-lag phenomenon (Freedman & Held, 1960) and the studies summarized by Nagatsuka (1965), may be interpreted as occurring as a function of increased vividness and duration of perceptual imagery. The second hypothesis concerning changes in the cognitive perceptual structure following isolation cannot be rejected, however, until similar studies are conducted with more varied and familiar stimulus domains.

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NOTES

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