Incidental learning and the timing of arousal¹

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Extrovert and introvert Ss were exposed to 16 paired-associate items. Four items were presented with white noise: (SR) for 4 sec during initial appearance of stimulus term alone and subsequent appearance of stimulus and response terms together, or (S) for 2 sec during initial appearance of stimulus term, or (R) for 2 sec during appearance of stimulus and response terms together, or (O) not on at all. After 24 h, recall was better with extroverts and with white-noise Conditions S and R.

Effects of arousal on verbal learning have been investigated with the help of several techniques. Learning has been compared for items generating greater and lesser degrees of arousal increase as shown by EEG (e.g., Thompson & Obrist, 1964) and GSR (e.g., Kleinsmith & Kaplan, 1963) indices, in Ss differing along personality dimensions that appear to entail differences in arousal or arousability such as manifest anxiety (e.g., Montague, 1963) and introversion-extroversion (e.g., McLaughlin & Eysenck, 1967), and in the presence and absence of arousal-raising stimulation, kinesthetic (e.g., Bills, 1927) or auditory (e.g., Hörmann & Todt, 1960; Schönplug & Beike, 1964; Berlyne et al, 1965).

White noise, which has been shown to increase multiple-unit activity in the reticular arousal system (Podvoll & Goodman, 1967), has the advantages that E can switch it on and off at will and that it can be used to raise arousal during learning and not during a recall test. In an experiment on intentional paired-associate learning (Berlyne, Borsa, Hamacher, & Koenig, 1966), white noise during the presentation of stimulus and response terms facilitated long-term recall. The present experiment was designed to investigate further the timing of the effects of heightened arousal and thus to throw further light on the role of arousal in verbal learning. Incidental learning was used to avoid the powerful motivational, and presumably arousal-raising, effects of instructions to learn. Recall was tested 24 h after learning to make sure that we were dealing with durable learning effects and not merely with transient performance effects (Berlyne, 1967). In view of evidence (Eysenck, 1967) that introverts have lower thresholds for arousal increment, and thus higher prevailing arousal levels, than extroverts, Ss were taken from the extremes of this dimension to find out whether white noise would affect the two kinds of personality differently.

METHOD

Subjects

The Eysenck Personality Inventory (Form A) was administered to 350 undergraduates taking an introductory psychology course. An Introvert group and an Extrovert group, each of 32 Ss with approximately equal numbers of males and females, were selected for the experiment. Their mean scores on the inventory were, respectively, 6.5 (with a range of 1-10) and 17.0 (with a range of 16-19). Ages ranged from 17 to 24.

Procedure

A Grass photoelectric Plethysmograph, attached to a cable, was clipped to S's right forefinger. He was told that the purpose of the experiment was to record physiological reactions while he was looking at foreign and English words. Nothing was said about learning or about a recall test.

The S then went through the training list of 16 paired-associate items. The stimulus term of every item was a Turkish word, paired with its English equivalent as response

term. The Turkish word appeared in the aperture of a Stowe memory drum for 2 sec. Then, the shutter of the memory drum rose, revealing the response term next to its stimulus term for 2 sec. Then, there was an interval of 4 sec, during which S had to pronounce both the Turkish and English words that he had just seen. At the end of this interval, the next item was exposed.

Four consecutive sub-lists of four items were presented with different white-noise conditions. These conditions were as follows: (SR)—4 sec of white noise coinciding with the exposure of the stimulus term alone and of the stimulus term and response term together, (S)—2 sec of white noise coinciding with the exposure of the stimulus term alone, (R)—2 sec of white noise coinciding with the exposure of the stimulus and response terms together, and (O)—no white noise. While the four sub-lists were given to every S in the same order, equal numbers of Ss in both Introvert and Extrovert groups had the four white-noise conditions in four different sequences corresponding to the columns of a counterbalanced Latin square. White noise was delivered through earphones, and its intensity was between 85 and 90 dB.

Approximately 24 h later, S returned and went through the test list. This consisted of the stimulus terms (Turkish words) alone in a randomized order with the restriction that one item in each consecutive set of four came from each of the four sub-lists used during the learning session. Each Turkish word appeared for 6 sec, during which S was to pronounce it and, if he could, also the English word that had been paired with it. He was instructed to guess if not certain. No white noise was presented during the test session, but the earphones were worn to exclude extraneous sound.

RESULTS

In most cases, no response term was recalled from a sub-list, and, in other cases, the number of correct responses was one or two. Because of this distribution, nonparametric tests were used throughout. Mean recall scores are displayed in Fig. 1.

The mean recall score (out of 16) was higher for Extroverts (0.87) than for Introverts (0.34). This difference is significant according to Wilcoxon's ranked-sum test: $z = 2.48$, $p < .02$.

The four white-noise conditions produced significantly different scores over all Ss ($\chi^2_r = 8.23$, $df = 3$, $p < .05$) but not for either the Introvert or the Extrovert group separately. Wilcoxon signed-rank tests were used to examine the following orthogonal contrasts: (1) white noise or no white noise during

Fig. 1.

stimulus term (Conditions S + SR vs R + O), (2) white noise or no white noise during simultaneous exposure of stimulus and response terms (SR + R vs S + O), and (3) the presence of a change (onset or offset of white noise) coinciding with the appearance of the response term (S + R vs SR + O). The presence of the noise while the stimulus term appeared alone was significantly detrimental to recall in Extroverts ($T = 34$, $N = 18$, $p < .05$) but did not make a significant difference to Introverts or to all Ss combined. White noise during the appearance of stimulus and response terms together had no significant effect. The most marked effect of white noise was the superior recall of items learned under Conditions S and R. These two conditions produced significantly better recall than the other two over all Ss ($z = 2.76$, $n = 33$, $p < .01$) and in Extroverts ($T = 51$, $N = 21$, $p < .05$).

In the Extrovert group, the difference between recall of items learned under the S and R conditions did not reach significance according to a Wilcoxon signed-ranks test, and in the Introvert group mean recall scores under the two conditions were equal. It will be noted that the proportions of total correct recalls belonging to the S and R conditions were similar in the two groups—75% in the Extroverts and 77% in the Introverts.

DISCUSSION

Howarth (in press) found long-term recall to be better in Introverts after intentional learning to criterion of moderately easy paired associates. On the other hand, in short-term recall, introverts are more proficient than extroverts with easy material, involving little inter-item interference, and less proficient with difficult material (McLaughlin & Eysenck, 1967). The same applies to high-anxiety Ss, who, like introverts, can be presumed to have relatively high arousal levels (Montague, 1953). Our Turkish words, which will have been unfamiliar and hard to distinguish for our Ss, must have been comparable to the difficult material used by these other experimenters. It is, therefore, interesting and not surprising that the Extroverts did better, although, in contrast with the experiments cited, long-term recall after incidental learning was tested. This finding, together with others, provides some measure of confirmation for a conclusion offered elsewhere (Berlyne, 1967). It does not seem that higher arousal during learning invariably makes for better long-term recall but worse short-term recall, as the Michigan group has asserted (Kleinsmith & Kaplan, 1963; Walker & Tarte, 1963). It seems, rather, that there is an optimal, intermediate degree of arousal for learning, the location of the optimum varying with the nature of the material and the interval between learning and recall (Berlyne, 1967).

The other principal result of our experiment was the superior recall of items learned under the S and R conditions, which involved, respectively, termination and onset of white noise at the precise moment when the response term was revealed. Sokolov's (1958) work led him to conclude that either the onset or the termination of a stimulus is likely to induce an orientation reaction (which includes a transient rise in arousal—Berlyne, 1960). Our finding this provides some confirmation for the hypothesis, put forward by several writers (e.g., Vinogradova, 1959; Maltzman & Raskin, 1965) and supported by a diversity of evidence, that the orientation reaction promotes learning. In particular, it is compatible with

the view (Berlyne, 1967) that a moderate arousal increment coinciding with, or closely following, a response to be learned (in our experiments, the internal response of reading the response term) provides reinforcement.

There was no sign of a difference in the effectiveness of the S and R conditions between Introverts and Extroverts. A more sensitive experiment might reveal such a difference. Several animal and human experiments suggest that an arousal-raising stimulus that is reinforcing under moderate arousal may be less reinforcing when arousal is higher (Berlyne, 1967).

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NOTES

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