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THE FIGURAL AFTER-EFFECT AND LYSERGIC ACID DIETHYLAMIDE (LSD-25)

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There have been numerous reports concerning the psychological and physiological effects of lysergic acid diethylamide (hereafter LSD; *cf.* 2). Some investigators have indicated that LSD in normal subjects produces symptoms which have much in common with schizophrenia. Physiological studies have shown that LSD affects the conduction of stimuli at various levels in the central nervous system. For example, it has been reported that the drug produces a marked rise in the absolute visual threshold (1) and has a general inhibitory effect upon synaptic transmission in the brain (6).

On the basis of these physiological studies it can be hypothesized that the inhibitory action of LSD may be similar in effect to what Köhler and Wallach (5) have referred to as a relatively high level of homogeneous satiation (generalized inhibition) in their study of figural after-effect phenomena. According to Köhler and Wallach's theory, an increase in the level of homogeneous satiation will produce a decrease in the magnitude of the figural after-effect. Thus it can be predicted that LSD will decrease the magnitude of the figural after-effect. The first purpose of the present study was to test this prediction. Its second purpose was to compare the effect of LSD on the figural after-effect with the after-effect of an acute schizophrenic group (4), using the same apparatus and procedure for each.

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METHOD

Subjects: Ten male alcoholic patients with an average drinking time (history) of 17.7 years were used in this study. The age range of this group was 24–46 (mean, 39.7 years). The age range of the schizophrenic group was 18–56 with a mean of 34.9 years. This age difference is not statistically significant. Each alcoholic patient received a dose of 200 gamma of LSD for therapeutic purposes as described in a previous study by one of the authors (3). This is a dose that would cause a very intensive reaction in most normal subjects. Alcoholics, however, are relatively resistant to this drug and 200 gamma had been arrived at as a dose that caused a sufficient but not excessive reaction in the average patient within this group. These patients were chosen on the basis of being the ten next male patients to be treated after the initiation of this study.

Apparatus and procedure: The apparatus and procedure were the same as in an earlier study (4). Each subject (*S*) was tested twice:[4] one day before receiving LSD and eight hours after LSD. Briefly, *S*'s task was to put his head in a headrest and look into a dark tunnel at the end of which he saw two illuminated vertical lines, one above another, and a red fixation point. He was instructed to look at the fixation point and

[4] *S*s were not available for testing until eight hours after receiving LSD. Since these patients were released from the hospital soon after receiving the drug, it was not possible to use a switch-back design.

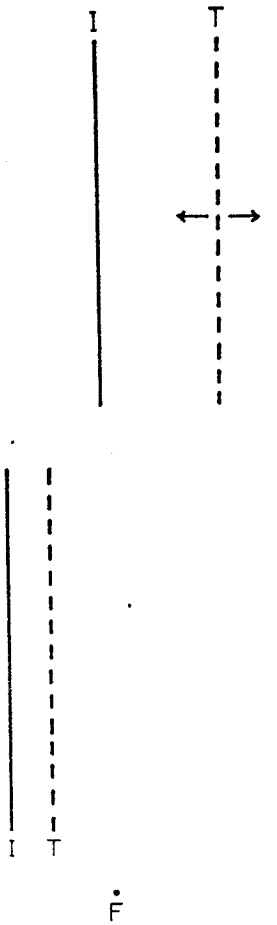

FIG. 1. Drawing of stimulus figures (one upper and one lower illuminated line against a dark background) showing the relative positions of the I- and T-lines and fixation (F-) point.

turn a knob which moved the upper line until the bottom and top lines appeared as one straight line. Before each alignment both lines (each 0.750 inch long and 0.001 inch wide) were placed in the positions marked T as shown in Figure 1. (The lower T-line was 0.250 inch above and 0.250 inch to *S*'s left of the fixation (F-) point; the upper line was 1.250 inch above and placed, before each alignment, at a random distance of 0.050 to 0.250 inch to *S*'s right of the F-point.) This procedure was continued until *S* could make each alignment in eight to ten seconds and not vary more than 0.05 inch between settings. When this criterion was reached, *S* was given a two-minute rest and then made four more such alignments, each separated by 30 seconds, which served as control settings. While *S* was given a two-minute rest, the two illuminated lines were moved to the positions marked I as shown in Figure 1. (The lower I-line was 0.250 inch above and 0.440 inch to *S*'s left of the F-point; the upper line was 1.250 inch above and 0.035 inch to *S*'s left of the F-point.) *S* was then instructed to look at the F-point for ten seconds (inspection period) after which the lines were immediately moved to the T-positions and *S*, continuing to look at the F-point, made three alignments: immediately, 30 and 60 seconds after the inspection period. These alignments are a measure of *S*'s recovery from the satiation or inhibition produced by the ten-second inspection of the lines in the I-positions and are referred to hereafter as test-time settings. Four such inspection periods and respective test alignments were made, each separated by two minutes. Two minutes after the last test alignment *S* made four more control settings (without inspection), each separated by 30 seconds.

With the lines in the I-positions, the ten-second inspection period produces what Köhler and Wallach have called a gradient of satiation, or inhibition, extending from the I-lines. When these lines are moved to the T-positions they are, as a result of these gradients of inhibition (at the visual cortex), phenomenally displaced away from the area originally occupied by the I-lines. That is, the lower T-line is displaced to *S*'s right, and the upper line, in the near alignment position, is displaced to *S*'s left. The magnitude of this displacement is calculated by subtracting the control setting (without inspection) from the settings made after the inspection period (experimental settings). In other words, this means that *S*, following the inspection period, will see the lines as being aligned when the upper line is objectively to his *right* of his control setting. This is the usual "positive" figural after-effect.

If, however, *S* sees the lines as being aligned when objectively the upper line has been adjusted to his *left* of his control setting, the magnitude in this direction is referred to as a "negative" after-effect.

RESULTS

The four control alignments made before the inspection periods and the four made at the end of the session were averaged, and served as the control alignment. The group mean control alignments in the before and after LSD conditions were not significantly different ($t = 0.83$, $p > .40$). The control alignments in this study compared with earlier and subsequent investigations with schizophrenic and normal groups have not been significantly different either in accuracy or variability. The four test alignments made at each of the three test-times were averaged, representing the experimental alignment for each test-time. The difference between the mean control and the mean experimental settings was a measure of *S*'s figural after-effect.

The main findings of this investigation are summarized in Figure 2, where the group mean magnitudes of figural displacement are plotted against test-time. The group mean magnitudes of displacement in the before and after LSD conditions were significantly different at the immediate and 30-second tests (one-tailed $t = 2.5$, $p < .025$; $t = 3.4$, $p < .005$, respectively), but not statistically different at 60-second test ($t = 1.09$, $p > .15$). The group mean displacements in the after LSD condition and the schizophrenic group (4, Exp. II) were not significantly different at the immediate and 30-second tests, but statistically different at 60-second test (two-tailed test, $p < .05$). The magnitudes of displacement in the before LSD condition and schizophrenic group were significantly different ($p < .001$ by two-tailed tests) at all test-times. At the 30-second test, one *S* in the before-LSD and nine *S*s in the after-LSD condition showed a "negative" displacement; at the 60-second test two *S*s without LSD and five *S*s with LSD displayed the negative effect. This compares with nine out of ten and all ten schizophrenic patients who showed a negative effect at the 30-second and 60-second tests, respectively, in the earlier study (4). (It might also be mentioned that subsequent investigation has shown that the figural after-effect of alcoholic and normal *S*s has not differed significantly.)

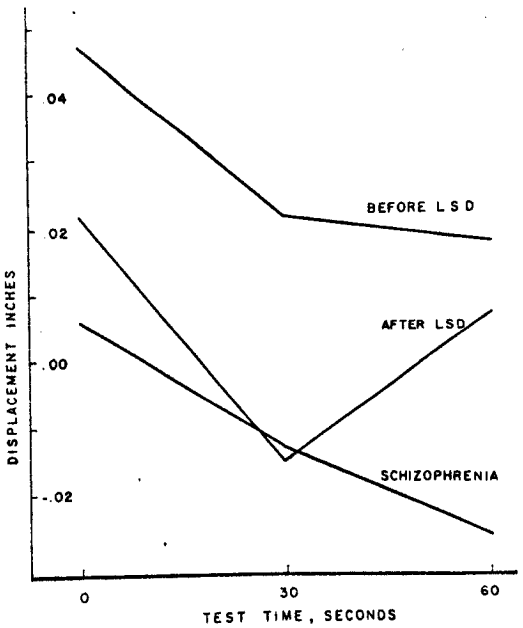

Fig. 2. Group mean magnitudes of figural after-effect.

DISCUSSION

The main findings of the present study confirm the prediction made earlier that LSD will decrease the magnitude of the figural after-effect. In addition, the results reveal the presence of a so-called negative after-effect when measurements were made 30 seconds after inspection. This negative effect was similar to a phenomenon reported in an earlier study with a group of acute schizophrenic patients (4). A comparison of the results of these two studies shows that the *S*s with LSD did not differ significantly from the schizophrenic group at any of the

test-times except the 60-second test period. In this test condition only half the LSD *Ss* displayed the negative effect while all the schizophrenic *Ss* showed a negative effect. Further research is needed to determine the parameters related to this negative effect.

It is possible that the above observed differences may be due to LSD effects on ability to cooperate or impairment of *Ss'* capacity to make the required judgment, and may not necessarily be related to the hypothesized difference in development and recovery from inhibition. If this were the case, however, one would expect greater variability between the judgments made with LSD and without this drug, which is not supported by the data. Furthermore, if the above possibility were true, one would not expect the consistent pattern of test alignments as found in this study. Finally, if the above criticism were valid, one would expect differences in accuracy and especially variability in the control judgments between the drug and non-drug conditions, and between the normal and schizophrenic groups. As pointed out earlier, the control alignments in this study, as well as those in other investigations with schizophrenic and normal *Ss*, have not been found to differ significantly either in accuracy or variability. These data, therefore, would tend to militate against the possibility that the results of this and earlier studies are due to the degree of cooperation or capacity of *S* to make the necessary judgment.

The results of this study and earlier investigations raise an interesting hypothesis concerning the cortical functioning of the schizophrenic patient. The schizophrenic shows a figural after-effect pattern similar to that which would theoretically be expected from an individual with a high level of generalized cortical inhibition. This is a notion which perhaps should be considered in further studies of the figural after-effect in atypical groups such as acute schizophrenic patients.

The results of these studies also suggest the possible usefulness of the measurement of the figural after-effect as a technique in the study of LSD, related substances and various psychiatric disorders.

SUMMARY

Lysergic acid diethylamide (LSD-25) administered to alcoholic patients decreased the magnitude of the figural after-effect and produced a so-called negative effect. The magnitude of the after-effect and the negative phenomenon were similar to the results reported in an earlier study with a group of acute schizophrenic patients. The LSD and schizophrenic figural after-effect patterns were similar to that which would theoretically be expected from an individual with a high level of generalized cortical inhibition.

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