

Influence of Lysergic Acid Diethylamide (LSD-25) on Subjective Time

H. ARONSON, Ph.D.; A. B. SILVERSTEIN, Ph.D., and G. D. KLEE, M.D., Baltimore

Introduction

Various reports^{1,14} have shown that the subjective sense of time can be considerably altered through changes in the external circumstances under which the judgment is made. Somewhat less is known of the influence of the subject's physical state on his ability to estimate time. This lack may be at least partially due to the fact that most conditions, such as fever or delirium, which have been described as bringing about such changes often simultaneously make it difficult or impossible to collect systematic data. When physical states are experimentally induced, however, the effects can be better controlled and tested. In this way, information has been obtained on the influence of nitrous oxide¹³ and mescaline^{6,8} on the sense of time.

The very striking effect of lysergic acid diethylamide (LSD-25) on the sense of time has been described in various ways by those who have observed the reaction: "Time sense . . . was characterized by the feeling of being accelerated or retarded"³; "Not only is there impaired ability to estimate the passage of time, but there is also a sense of timelessness."⁹ Yet Boardman and associates,² who studied systematically the judgment of time under LSD-25, found only an increase in variability and no change in the direction of the estimate. It appeared reasonable that, with such striking changes described as common to the drug, more definite results could be expected.

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The Psychiatric Institute, University of Maryland.

Method

The subjects were 24 men who had been screened by physical examination, psychiatric interview, and group psychological testing as being within normal limits both physically and mentally. They were divided arbitrarily into two experimental groups of equal size, one tested first under LSD-25 and then acting as its own normal control (Group D-C), and a second, for which this order was reversed (Group C-D). The interval between the two tests varied from three days to a week. The drug testing was initiated two to three hours after ingestion of either 1 μ g. or 2 μ g. of LSD-25 per kilogram of body weight. Three subjects in each group were given the larger drug dose. Placebos were not given for the control condition.*

Four time intervals were chosen for testing: 15, 60, 120, and 240 minutes. Each subject was asked to estimate these same intervals twice, once under the drug and once in his normal state. Since it has been reported^{4,6} that practice produces a change in ability to estimate time, the four intervals were presented in a different sequence to each subject. Thus, no particular time interval was in a more "favorable" position than the others when the results were summated.

The judgments under both conditions were made by the "method of production"; that is, the subject was told the length of time he was to estimate and then given a signal to begin. He was instructed to notify the experimenter when the designated interval had elapsed.

No limits were placed on the subject's manner of making his estimate except that he was not allowed to use his watch or to see the experimental apparatus, an electric stop watch. The experiment was carried out in a small room near

*Facilities were not available to give the subjects the bed care and attention during the control session which would approximate the treatment given during the LSD-25 reaction. It was decided that a partial duplication of the experimental treatment, such as substituting tap water for LSD-25 administration, would be an inadequate attempt at proper control.

TABLE 1.—Median Time Judgments Under Drug and Control Conditions

	Interval to Be Produced, Min.			
	15	60	120	240
Control estimate.....	13.5	58.0	112.0	212.5
Drug estimate.....	11.0	44.5	71.5	140.5

that occupied by the other subjects being tested the same day. As the room was not soundproof, the sounds of voices and a radio in the next room could easily be heard.

The data, a total of eight judgments per subject, four under the drug and four under the control condition, were analyzed by means of the Mann-Whitney test and Wilcoxon's matched-pairs signed-ranks test.¹⁰ These nonparametric tests were chosen upon rejection of the assumption of normality and homogeneity of variance.

Results

Since the Mann-Whitney test did not show any significant interaction between the effect of the drug and the order in which the conditions were presented,¹¹ the data for Group D-C and for Group C-D were combined to determine the effects of the drug. Table 1 presents the median estimates for the two conditions. Under both experimental conditions there was an overestimation of the actual speed of the physical clock. However, the subjects judged the requested intervals of time to have elapsed more rapidly while under the drug than while under the control condition. Another way of stating this difference is that the subject's internal clocks ran more quickly under LSD-25 than in their normal states, so that, paradoxically, external events appeared to pass more slowly.

TABLE 2.—Effects of LSD-25 on the Estimation of Time Intervals

Interval, Min.	N	Sum of Ranks	Probability *
15	20 †	37	0.01
60	24	58.5	0.01
120	24	24.5	0.001
240	24	40.5	0.01

* Two-tailed test.

† Following Siegel,¹² four cases were omitted because the estimates under the two conditions were equal.

The results of the Wilcoxon matched-pairs signed-ranks test for drug effect are shown in Table 2. At each interval the subjects' time judgments were significantly lower under the drug than under the control condition. At 15, 60, and 240 minutes the probability is less than 1 in 100 that the difference is due to chance; at 120 minutes the probability is less than 1 in 1,000.

Comment

The results of this experiment are in agreement with published descriptions of the LSD-25 phenomena in finding a disturbance of normal temporal judgment. While the previous descriptions emphasize change in conceptual time, these results point out not only a difference in function but also a rather consistent direction of the change. Time does not merely pass differently; it appears to pass more slowly than usual. It must be remembered, however, that the findings here are limited to a specific time period of two to three hours after the ingestion of LSD-25. It is conceivable that other intervals during the drug's relatively long span of effect may manifest a different or less consistent temporal change. For example, it is possible, that the drug initially slows a pertinent physiological process and then speeds it later in the drug sequence.

Such a change in the effect of the drug may explain the lack of consistent error in judgment reported by Boardman, since the data of that experiment were collected over a broad range of the activity of the drug, rather than at a specific time in the reaction. However, there are other hypotheses which may explain the discrepancy between the results reported here and those of Boardman and associates. For example, the latter group studied the ability to estimate a one-minute period, whereas the present study focused on longer periods. Very little is known about the mechanisms used to judge time, and it is quite possible that the judgment of very short periods involves different clues and abilities than those necessary for judging longer intervals.

Perhaps a more serious difference between the present study and that reported by Boardman is one of procedure. In the earlier study the subject was presented with a series of stimuli which differed, one from the next, by 0.1 minute. This series was presented in alternately ascending and descending order, and the task was to judge whether each stimulus was greater than or less than one minute. Such a presentation may well have introduced the extraneous factor of perceptual rigidity, i. e., difficulty in perceiving a change in a stimulus when it is altered very gradually. Perceptual rigidity has been found to relate to a concrete attitude on the part of the perceiver,⁷ and it is known that LSD-25 does produce a greater concreteness in thinking.¹² An increase in perceptual rigidity might explain the increased variability with no constant change in direction which was found by Boardman.

Granted that the results reported here do reflect a change in temporal perception, it is difficult to ascertain a reason for that change. One explanation of temporal perception is based upon the assumption that there exists one or more physiological regulators, i. e., heart rate or rate of breathing. Thus, when the physical state is altered in a manner affecting the regulator, or internal clock, time would appear to pass at a different rate. Certainly, since LSD-25 does disturb the normal physical state, this interpretation cannot be rejected.

Another hypothesis often called upon to explain changes in the subjective passage of time involves the subject's evaluation of how the time is spent. To give a few greatly simplified examples: One may expect a dull or painful period to pass slowly; an interesting one, quickly; an active one, quickly. In that the time spent under the influence of LSD-25 is generally considered very different from usual, and is frequently reported as unpleasant, a judgment made under the drug that time appears to be passing slowly would also be consistent with this psychological interpretation of the phenomena.

While the preceding paragraphs suggest a number of relatively specific factors which may account for the observed disturbance in temporal judgment, the point should be made that temporal orientation may well be dependent upon a combination of factors rather than being a function of any single one. Even such an apparently simple judgment as the localization of an auditory stimulus has been found to depend not only upon auditory cues but also upon visual cues and expectations built upon past experience. It is a reasonable hypothesis that temporal judgments may be based on the utilization of an even more complex array of cues, and that either the failure to receive cues or the failure to integrate them properly may result in a disturbance of temporal orientation. Thus, the observed effects of LSD-25 on temporal judgment may be not only concurrent with but also directly dependent upon the extensive impairment of perceptual and conceptual functioning which the drug is known to produce.

Summary

Twenty-four subjects were used as their own controls to determine the effect of lysergic acid diethylamide (LSD-25) on the subjective passage of time. Under the drug the subjects overestimated the stimulus intervals to a significant degree, indicating that the drug has the effect of making time appear to pass more slowly than usual. The results of this study were unlike those reported in an earlier experiment, in which no consistent changes were found under the drug. Differences between experimental procedures were discussed to suggest reasons for the divergent results. The findings were examined for theoretical implications in light of other changes noted as common to the LSD-25 reaction.

The Psychiatric Institute, University of Maryland.

REFERENCES

1. Axel, R.: Estimation of Time, Arch. Psychol., Monograph, Vol. 74, 1924.

2. Boardman, W. K.; Goldstone, S., and Lhamon, W. T.: Effects of Lysergic Acid Diethylamide (LSD) on the Time Sense of Normals: A Preliminary Report, *A. M. A. Arch. Neurol. & Psychiat.* 78:321-324, 1957.
3. DeShon, H. J.; Rinkel, M., and Solomon, H. C.: Mental Changes Experimentally Produced by LSD (d-Lysergic Acid Diethylamide Tartrate), *Psychiat. Quart.* 26:33-53, 1952.
4. Eson, M. E., and Kafka, J. S.: Diagnostic Implications of a Study in Time Perception, *J. Gen. Psychol.* 46:169-183, 1952.
5. Falk, J. L., and Bindra, D.: Judgment of Time as a Function of Serial Position and Stress, *J. Exper. Psychol.* 47:279-282, 1954.
6. Favilli, M.: La percezione del tempo nell'ebbrezza mescalina, *Rass. studi psichiat.* 26:455-462, 1937.
7. Frenkel-Brunswik, E.: Intolerance of Ambiguity as an Emotional and Perceptual Personality Variable, *J. Person.* 18:108-143, 1949.
8. Fröbes, J.: *Lehrbuch der experimentellen Psychologie*, B. I, Freiberg, Herder, 1923.
9. Savage, C.: Variations in Ego Feeling Induced by d-Lysergic Acid Diethylamide (LSD-25), *Psychoanalyt. Rev.* 42:1-16, 1955.
10. Siegel, S.: *Nonparametric Statistics for the Behavioral Sciences*, New York, McGraw-Hill Book Company, Inc., 1956.
11. Silverstein, A. B.: Nonparametric Tests for the Comparison of Changes, *Psychol. Rep.* 4:582, 1958.
12. Silverstein, A. B., and Klee, G. D.: Effects of Lysergic Acid Diethylamide (LSD-25) on Intellectual Functions, *A. M. A. Arch. Neurol. & Psychiat.* 80:477-480, 1958.
13. Steinberg, H.: Changes in Time Perception Induced by an Anaesthetic Drug, *Brit. J. Psychol.* 46:273-279, 1955.
14. Woodrow, H.: Time Perception, in *Handbook of Experimental Psychology*, edited by S. S. Stevens, New York, John Wiley & Sons, Inc., 1951, Chap. 32.