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LYSERGIC ACID DIETHYLAMIDE (LSD-25): XVIII. EFFECTS OF LSD-25 AND SIX RELATED DRUGS UPON HANDWRITING*

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A. INTRODUCTION

Weyl (8) demonstrated that the handwriting of subjects about three to four hours after they received LSD-25 appeared large, illegible, and uncontrolled in contrast to their handwriting in the non-drug state. Incidental observations of handwriting and figure and Bender-Gestalt drawings of subjects tested in this laboratory indicate similar changes after LSD-25 ingestion. Results on a pursuit-rotor test and a steadiness test demonstrated that the drug decreased motor control (1).

Subjects under LSD-25 reported on questionnaires that they were unsteady, uncoordinated, and their movements lacked control (2, 4). When six drugs in addition to LSD-25 were studied, the results demonstrated that whereas little effect was produced by tap water placebos, a moderate effect on these functions was induced by drugs other than LSD-25, with a remarkably increased effect from lysergic acid diethylamide (4).

The purpose of this paper is to measure differences in the handwriting of subjects under the influence of a tap water placebo and seven related drugs: LSD-25 (lysergic acid diethylamide), LAE-32 (lysergic acid monoethylamide), BOL-148 (d-1-brom lysergic acid diethylamide), Ergonivine (ergometrine), ethyl alcohol, Pervitin or Methedrine (methamphetamine hydrochloride), and scopolamine (hyoscine). The relationship among these drugs is explained in another paper (4). The handwriting variables studied were suggested by the works of Castelnuovo-Tedesco (3), Roman (6), Saudek (7), and Wolfson (9).

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B. METHOD

1. *Subjects*

There were three male and two female paid adult volunteers, considered non-psychotic on the basis of a psychiatric interview and a Rorschach test. The median age was 26, ranging from 24 to 32 years. Body weight of the group ranged from 130 to 180 pounds, with the median at 150. There were three graduate students, a photographer, and an advertising trainee in the group.

2. *Tests*

On each experimental day the subjects copied verbatim a poem (5). They wrote the poem on a standard 8½ x 11 inch sheet of paper. At the top of the page there were mimeographed blanks to be filled in with the subject's name, the date, the test, and the time.

3. *Procedure*

a. Drug administration. In administering the drugs, a double-blind procedure was followed wherein neither the subjects nor those administering the drugs knew which substance the subjects received on a given day.

In addition to the seven drugs studied, two tap water placebos were given. The five subjects were tested together during each experiment. On the first day all subjects received a placebo consisting of only 200 cc of tap water. During the remaining eight experiments, which were held at intervals of from two to six days, the drugs and a second placebo were each given once. No two subjects received the same drug in any one day. Table 1 indicates

TABLE 1
DRUGS RECEIVED ON EACH EXPERIMENTAL DAY BY EACH SUBJECT

Subject	Drugs								
	Placebo No. 1	LAE-32	Scopolamine	Placebo No. 2	Methamphetamine	LSD-25	BOL-148	Alcohol	Ergonovine
A	1	2	3	4	5	6	7	8	9
B	1	5	6	7	8	9	2	3	4
C	1	3	4	5	6	7	8	9	2
D	1	8	9	2	3	4	5	6	7
E	1	7	8	9	2	3	4	5	6

Note: Numbers 1 through 9 indicate the day on which the subjects received each drug.

the substance received by each subject on the given experimental day. The doses of the drugs were as follows: BOL-148 and LAE-32, .005 milligrams per kilogram body weight on the second experimental day and .007 milligrams per kilogram body weight on other days; methamphetamine, 7.5 milligrams per total body weight; LSD-25, .001 milligrams per kilogram body weight; alcohol, 45,000 milligrams per total body weight; Ergonovine, .65 milligrams per total body weight; and scopolamine, 1.3 milligrams per total body weight. Each drug was diluted in 200 cc of tap water. None of the drugs had any color and only alcohol had a taste and an odor. Subjects could not detect what substance they received.

The substances were administered orally at 9:30 A.M., except for the first placebo, which was given at 10:00 A.M. The subjects had eaten no food since the previous evening. One-half hour after the ingestion of the drug or placebo they ate a light breakfast. No smoking was allowed and no stimulants, such as coffee or tea, were permitted during the experimental period.

b. Test administration. The following instructions were given to the subjects: "Take a blank form and after *test*, write *handwriting*. Fill in the correct time. Now, copy this paragraph exactly as you see it here."

The test was given about 4½ hours after the ingestion of the substances, except for the first day when it was given about 15 minutes after the placebo. The subjects took a variety of other tests before and after the handwriting test.

c. Analysis of data. Certain aspects of the subjects' handwriting in copying the poem were analyzed. These were: (*a*) total area used to copy the poem, (*b*) average height of capital letters, (*c*) number of errors in spelling, punctuation, and copying detail, (*d*) number of erasures, deletions, corrections, and cases of "mending," (*e*) slant of writing, (*f*) slant of first and of last line, (*g*) carefulness in dotting i's and crossing t's, (*h*) word spacing, (*i*) letter size, and (*j*) pencil pressure. The first four aspects were measured, whereas the others were estimated. The total area was that enclosed by lines drawn parallel to the sides of the sheet along the outermost extension of letters on each side. Each sample was analyzed individually and group trends were noted whenever they existed.

C. RESULTS

Tables 2 through 6 summarize the results of the four relatively objective measures made for each handwriting sample. The data for each subject appear on a separate table.

The total area used by Subject *A* ranged from 104.4 square cm to 121.0

square cm after receiving the two placebos, Ergonovine, and methamphetamine, as shown in Table 2. It ranked from 127.9 square cm to 179.3 square cm after he received the other drugs. When under the influence of LAE-32 and scopolamine the subject used the greatest space. There was

TABLE 2
QUANTITATIVE ANALYSIS OF HANDWRITING SAMPLES OF SUBJECT *A*: (A POEM WAS
COPIED DURING 9 EXPERIMENTS)

Item	Substance received								
	Water placebos		Drugs						
	No. 1	No. 2	Ergonovine	Alcohol	Scopolamine	BOL-148	Methamphet- amine	LAE-32	LSD-25
a. Total area, in square centimeters	104.4	121.0	118.8	149.5	168.6	147.0	127.4	179.3	154.7
b. Average height of capital letters, in centimeters	.6	.6	.6	.6	.7	.8	.6	.7	.7
c. Number of errors in spelling, punctuation, and copying	2	2	2	2	5	2	3	2	2
d. Number of erasures, deletions, corrections, and cases of "mending"	0	1	0	0	7	1	3	1	1

little variability in the average height of the capital letters. The greatest number of errors in spelling and punctuation and the greatest number of erasures, deletions, corrections, and cases of "mending," occurred after scopolamine; the second greatest number occurred after methamphetamine. The results after the other substances were fairly comparable. This subject wrote most irregularly after LSD-25 and scopolamine; his pencil pressure was greatest after receiving methamphetamine, LAE-32, and scopolamine. The size of the writing tended to correspond with total area. There were no other outstanding differences related to specific drugs.

Table 3 summarizes the analysis of Subject *B*'s handwriting. The total

area she used was generally greater than that used by other subjects. Under alcohol she used the smallest area and under the second placebo she used the greatest. Data from the first placebo experiment are missing. The average height of the capital letters was smallest after the placebo and larg-

TABLE 3
QUANTITATIVE ANALYSIS OF HANDWRITING SAMPLES OF SUBJECT B: (A POEM WAS COPIED DURING 9 EXPERIMENTS)

Item	Substance received								
	Water placebos		Drugs						
	No. 1	No. 2	Ergonovine	Alcohol	Scopolamine	BOL-148	Methamphet-amine	LAE-32	LSD-25
a. Total area, in square centimeters	*	391.0	301.0	252.4	324.7	364.5	343.1	359.8	343.1
b. Average height of capital letters, in centimeters		.9	1.2	1.1	1.4	1.3	1.0	1.4	1.0
c. Number of errors in spelling, punctuation, and copying		2	4	3	3	2	2	3	2
d. Number of erasures, deletions, corrections, and cases of "mending"		1	0	0	0	0	1	0	0

*Data missing.

est after scopolamine and LAE-32. The greatest number of errors was made after the subject received Ergonovine; the number of erasures and corrections never exceeded one. Subjective analysis of her handwriting size showed that it was small when she received the placebo and large when she received BOL-148, Ergonovine, and LSD-25. Pencil pressure was greatest after alcohol and LSD-25.

Subject C demonstrated considerable variability in the area of her writing after she received different substances. The total area ranged from 111.3 square centimeters after LSD-25 to 264.6 square centimeters after the second placebo. The area occupied after the first placebo fell approximately in

the middle of the range. The average height of the capital letters was least after LSD-25 and greatest after the second placebo. The greatest number of errors was made after alcohol; the greatest number of erasures, after scopolamine. Pencil pressure was heaviest after the second placebo and

TABLE 4
QUANTITATIVE ANALYSIS OF HANDWRITING SAMPLES OF SUBJECT C: (A POEM WAS
COPIED DURING 9 EXPERIMENTS)

Item	Substance received								
	Water placebos		Drugs						
	No. 1	No. 2	Ergonovine	Alcohol	Scopolamine	BOL-148	Methamphet- amine	LAE-32	LSD-25
a. Total area, in square centimeters	154.1	264.6	164.0	125.0	160.7	127.0	175.8	155.2	111.3
b. Average height of capital letters, in centimeters	.8	1.1	.8	.8	.8	.7	.7	.7	.6
c. Number of errors in spelling, punctuation, and copying	2	0	2	5	2	3	2	3	1
d. Number of erasures, deletions, corrections, and cases of "mending"	0	0	0	2	3	0	0	0	0

after scopolamine. The writing was most careless and the spacing between words was closest when the subject was under the influence of alcohol.

The total area after different drugs was fairly consistent for Subject *D* in comparison with other subjects. It ranged from 152.9 square centimeters after the first placebo, to 220.5 square centimeters after LAE-32 and BOL-148, as shown in Table 5. Average capital letter size also varied little, but correlated with total area. There was one error made after scopolamine and one after LAE-32; otherwise there were no errors. There were 6 erasures after the subject received scopolamine and 3 after he received methamphetamine and LSD-25. He wrote largest after alcohol, BOL-148 and LAE-32. The writing always slanted toward the right, except after

he received BOL-148 and LSD-25, when the slant was irregular. Pencil pressure, although fairly consistent, was slightly lighter after the ingestion of Ergonovine and alcohol.

Subject *E* exhibited the greatest variability in total area used after the

TABLE 5
QUANTITATIVE ANALYSIS OF HANDWRITING SAMPLES OF SUBJECT *D*: (A POEM WAS
COPIED DURING 9 EXPERIMENTS)

Item	Substance received								
	Water placebos		Drugs						
	No. 1	No. 2	Ergonovine	Alcohol	Scopolamine	BOL-148	Methamphet-amine	LAE-32	LSD-25
a. Total area, in square centimeters	152.9	177.5	*	192.9	165.5	220.5	166.3	220.5	203.9
b. Average height of capital letters, in centimeters	.7	.8	.8	.9	.9	.9	.8	1.0	.8
c. Number of errors in spelling, punctuation, and copying	0	0	0	0	1	0	0	1	0
d. Number of erasures, deletions, corrections, and cases of "mending"	0	0	0	1	6	0	3	0	3

*Data missing.

different substances and showed the most pronounced handwriting change after LSD-25, when he used 496.8 square centimeters area; he had to use the reverse side of the page to complete the poem. He wrote smallest under the influence of LAE-32 where the total area used was 184.9 square centimeters. Capital letter size varied from .6 centimeters after the first placebo to 2.0 centimeters after LSD-25. The greatest number of errors was made after LSD-25, with a large number also occurring after the two placebos and scopolamine. Many erasures were made only after scopolamine. After LSD-25, the handwriting was most irregular and uncontrolled. Spacing between words was inconsistent; the subject was careless in dotting *i*'s and

crossing *t*'s, and wrote with the heaviest pencil pressure. After the placebos and LAE-32, pressure was lightest.

The handwriting protocols of two subjects after they received the second placebo and after they received LSD-25 appear in Figures 1 and 2. They

TABLE 6
QUANTITATIVE ANALYSIS OF HANDWRITING SAMPLES OF SUBJECT E: (A POEM WAS
COPIED DURING 9 EXPERIMENTS)

Item	Substance received								
	Water placebos		Drugs						
	No. 1	No. 2	Ergonovine	Alcohol	Scopolamine	BOL-148	Methamphet-amine	LAE-32	LSD-25
a. Total area, in square centimeters	215.3	235.6	215.8	253.5	226.0	300.1	228.8	184.9	496.8
b. Average height of capital letters, in centimeters	.6	1.2	.9	1.0	.9	1.1	1.1	.8	2.0
c. Number of errors in spelling, punctuation, and copying	4	5	2	1	4	1	1	2	7
d. Number of erasures, deletions, corrections, and cases of "mending"	1	0	0	0	6	0	1	1	1

demonstrate more vividly the kind of changes which can occur. These two subjects showed opposite tendencies when under the influence of LSD-25.

D. DISCUSSION

Despite the differences among subjects there are some generalizations which can be made about the handwriting changes occurring after the subjects receive certain drugs.

It is interesting that four subjects for whom data are available used a greater amount of space to copy the poem after the second placebo than after the first. This may be attributed to practice and decreased attention to the

task. The line slant of the first line and of the last line was the same in 8 out of 10 placebo experiments.

Scopolamine tends to lead to a very large number of erasures, deletions,

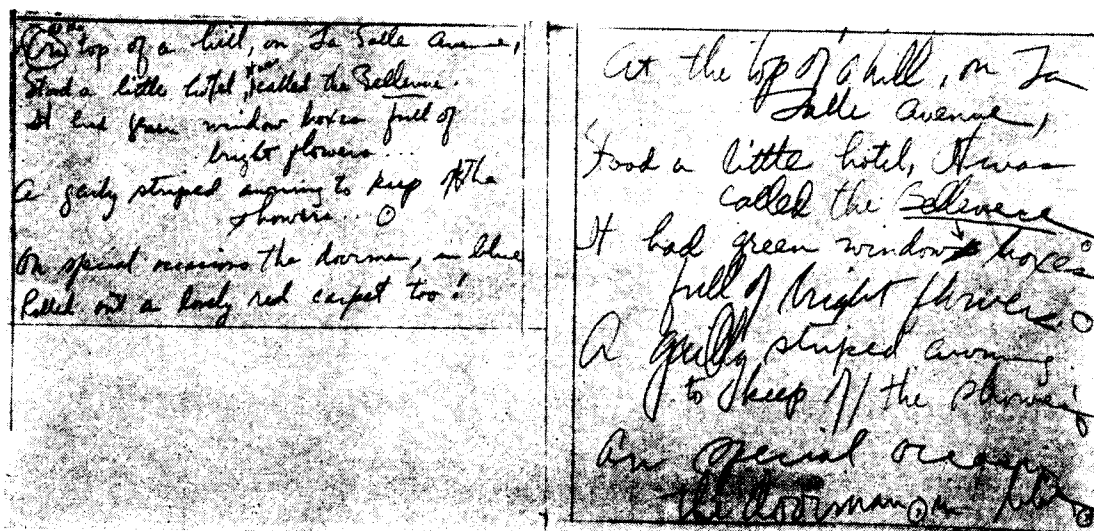


FIGURE 1

HANDWRITING PROTOCOL OF SUBJECT E, OBTAINED AFTER PLACEBO INGESTION (LEFT) AND LSD-25 INGESTION (RIGHT)

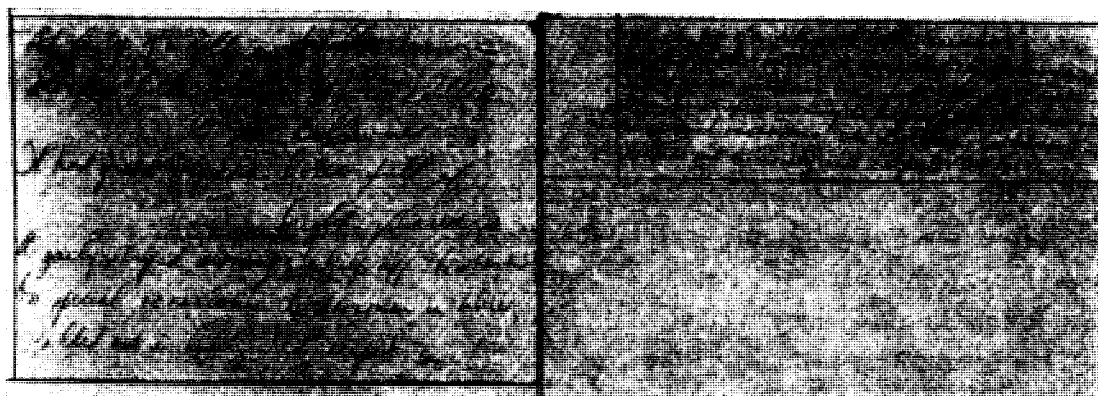


FIGURE 2

HANDWRITING PROTOCOL OF SUBJECT C, OBTAINED AFTER PLACEBO INGESTION (LEFT) AND LSD-25 INGESTION (RIGHT)

and corrections. This drug also produces extreme feelings of drowsiness in the same subjects (4), and drowsiness may interfere with the subjects' alertness and ability to perform efficiently. In four subjects there was a great deal of irregularity in form, letter size, word spacing, and slant of writing. The relative size of the handwriting and the area used after the subjects received

this drug varied; for some it was smaller than after most other drugs; for others, larger.

The handwriting of most subjects was relatively large under BOL-148 and relatively small under Ergonovine. Under these drugs and alcohol the subjects were able to maintain a consistent line slant. Under Ergonovine there were no erasures, etc., by any subject and under BOL-148 only one subject had an erasure. There was greater variability among the other drugs along these parameters.

The area used by three subjects was larger after they received LSD-25, BOL-148, and alcohol than after the placebos. Two subjects used the largest area under the second placebo and used little space under alcohol and LSD-25, showing opposite effects of these drugs. The relative positions of the placebo and other drugs was random and inconsistent.

Irregularity in letter size, word spacing, slant and lack of control in writing seem to characterize the writing of four subjects while under the influence of LSD-25. These changes did not seem to be present in the writing of one subject who wrote smallest under this drug. The slant of the first and of the last line differed for each of four subjects under LSD-25.

Subject *C* made more errors after alcohol than after any other drug, and more errors than other subjects made after alcohol. She also gave more positive responses to the questionnaire (4) than other subjects, suggesting that alcohol had a comparatively great effect upon her. Two subjects displayed irregularity in writing after alcohol.

There was some correlation between the handwriting changes and the number of positive questionnaire responses of Subject *C* after alcohol. For the group as a whole, the questionnaire showed that subjects gave relatively few responses following the water placebos and gave the greatest number of responses after LSD-25. No such clear-cut differentiation among substances was found in these handwriting samples.

Calling this test a *handwriting* test might motivate subjects to compensate for possible changes in their writing. Comparison of these handwriting samples with samples where memory and other factors were of major interest showed that, regardless of the test, the handwriting on a given day was fairly consistent.

E. SUMMARY AND CONCLUSIONS

Five non-psychotic, adult subjects received average effective doses of LSD-25, LAE-32, BOL-148, Ergonovine, alcohol, scopolamine, and methamphetamine, administered orally in 200 cc of tap water. They also received two tap water placebos. Each substance was given on a separate day; no

two subjects received the same drug the same day. About 4½ hours after receiving each substance the subjects copied a poem. Their handwriting was analyzed for total area, the average height of the capital letters, the number of errors in spelling, punctuation, and copying detail, and the number of erasures, deletions, corrections, and cases of "mending." Several subjective measures were also made; namely, letter size, line slant, pencil pressure, etc. The following tentative conclusions are made:

1. Subjects demonstrated considerable, individual variability in their handwriting, after receiving the different substances.

2. Under the influence of LSD-25, alcohol, and BOL-148, three subjects wrote much larger than after the placebos, and two wrote smaller. Under Ergonovine subjects generally wrote small.

3. The greatest number of errors and the greatest number of erasures, deletions, corrections, etc., tended to occur under scopolamine. This substance produces feelings of extreme drowsiness which may be a causal factor in the number of errors and corrections. No subject made any erasures, etc., after receiving Ergonovine, and only one subject made an erasure after BOL-148.

4. The greatest irregularity and carelessness in writing occurred after alcohol, scopolamine, and LSD-25, with the most noticeable effects related to LSD-25 ingestion. The other drugs had no widespread marked effects.

5. There was little relationship between the handwriting of subjects and subjective changes under the influence of the two placebos and the seven drugs. Subjective changes were measured by their responses to a questionnaire.

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