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LYSERGIC ACID DIETHYLAMIDE (LSD-25): XVI. THE
EFFECT ON INTELLECTUAL FUNCTIONING AS
MEASURED BY THE WECHSLER-BELLEVUE
INTELLIGENCE SCALE

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A. INTRODUCTION

1. *Purpose*

The purpose of this experiment was to study the effects of LSD-25 on the intellectual functioning of normal, i.e., non-psychotic, subjects. Specifically, the problem was to determine whether intelligence or intellectual functioning was affected by this drug, and if so, in what way it made itself felt. Since Wechsler's definition of intelligence as "the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (9) is generally accepted by most psychologists, and since the assumption may well be made that the Wechsler-Bellevue Intelligence Scale Form I is both a suitable as well as valid method to measure intelligence, as defined herein, this test was selected as the experimental tool for this study.

2. *History*

W. A. Stoll (8) was the first writer systematically to study LSD-25, using a psychological technique. He reported as his major findings with the Rorschach test that disturbances in perception led to hallucinations, acceleration of thinking, a slight dimming of consciousness, but with no impairment in judgment. He administered the Rorschach test at the height of the LSD-25 reaction to 11 persons assumed to be psychically normal, mostly physicians and female laboratory workers. There were four women and seven men in the 21 to 44 age range; average age 33. Ten persons tested received 30 micrograms and one only 20 micrograms of LSD-25. Nine were

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retested without the drug from 12 to 15 weeks later and two were retested one year later. Condrau (2) agreed with most of Stoll's findings, except that in his studies, he found the subject's consciousness was not disturbed aside from the feelings of intoxication. He reported further that distractibility increased in his subjects and that their ability to concentrate was impaired. Rinkel, DeShon, Hyde, and Solomon (5) gave LSD-25 in doses ranging from 20 to 90 micrograms, but for the most part at the rate of one microgram per kilogram body weight 17 times to 15 normal students, nurses, and doctors in the 19 to 48 age range. Rorschach tests were given to five subjects and concrete-abstract thinking tests were given to two subjects at the height of the LSD-25 reaction. These studies were controlled by testing the subjects in their normal mental state but the authors emphasize the clinical psychiatric nature of their observations. Although at one point in their paper they note that abstract thinking was frequently impaired they maintain that in their normal subjects, "intellectual functions were never disturbed" and that basic intelligence was not reduced. Savage (6) observed five normal control subjects and 15 depressed patients from both a psychological and physiological point of view. It is not clear at what point during the experiments the Wechsler-Bellevue tests were administered, for he states he tried "to test their subjects before they were handicapped by failure of accommodation." He reports that there was no significant difference obtained. Although there was difficulty in concentrating, there was no impairment in memory and in comprehension. His criterion of "normalcy" was "whether the subject was functioning adequately in his immediate life situation." His normal subjects received a single oral dose of 20 micrograms of the drug before breakfast, while the depressed patients were started on 20 micrograms and the dosage was increased daily until a definite psychophysical effect was obtained. The highest dose given was 100 micrograms. The purpose of Savage's study was to determine if LSD-25 might be useful in the treatment of depression, and unfortunately, no Wechsler-Bellevue Intelligence test data were presented. Gastout, Ferrer, Castelle, Lesevre, and Luschnot (3) found that attention and abstract thinking were impaired.

In view of the contrasting reports of the various experimenters, additional information as to what happens to the intellectual functioning level is needed. This appears especially indicated when it is noted that such varied usages for LSD-25 are contemplated, as for example, as an aid in therapy and as an agent that might provide us with some understanding of the rôle chemical substances play in the development of a psychosis.

B. METHOD

1. Procedure

In order to eliminate psychotic subjects from the experiment, a battery of psychological tests was administered to all volunteers to provide, among other things, a psychodynamic diagnostic formulation of each subject's basic personality. This battery consisted of the following: (a) Bender-Gestalt test, (b) House-Tree-Person test, (c) Word Association test, (d) Rorschach test, (e) Wechsler-Bellevue test, (f) Selected cards at the *TAT*.

These tests were generally given in the above order and usually required from 2½ to 3½ hours to administer. After the subject was selected as a non-psychotic, this battery of tests furnished control data for each subject.³ At a future date which ranged from 2½ weeks to 9 months after the control testing with an average interval of two months (actually only one subject was re-examined before five weeks had passed and he received Form II) the entire battery was again administered upon the completion of breakfast which was served ½ hour after the subject received LSD-25 orally. Under the drug, the testing period extended from 2½ to 6 hours depending upon the dosage and the individual being examined. Lunch was always served approximately 2½ hours after the drug was taken and usually provided a ½ hour to one hour break in testing. The Wechsler-Bellevue test was usually given right after lunch or approximately 3¼ hours after the drug was taken. A change in the retest or *During* battery was made after it had been noted as a fairly constant finding in the first 11 cases retested, that the subjects all reported an advantage in the Object Assembly subtest of the Wechsler-Bellevue test. Since it is to a great degree a measure of one's ability to recognize the familiar objects that make up this subtest, previous contact with these items facilitates performance. Consequently, it was decided to use Form II of the Wechsler-Bellevue Intelligence Scale in future retest batteries in order to eliminate this factor which might serve as an offsetting variable. Wechsler (10) reports that preliminary comparisons of the two Forms demonstrate a high correlation, and, perhaps what is even more important, a mean difference of less than two points between Full Scale scores. Subtest averages are also maintained between comparisons of individual subtests. Unfortunately, for our specific purpose in employing Scale II, the Object Assembly subtest is reported as a little easier than the

³It must be mentioned that in our conception of diagnostic categories latent psychotics are not considered psychotic. Rather, this diagnosis is viewed as basically a prediction that under some circumstances, which may be difficult to specify, the person will show schizophrenic behavior.

one included in Scale I, and the Comprehension test in Scale II is reported as a little harder than its comparable subtest in Scale I. Still, it was deemed desirable by us to use Form II in the event that it was necessary to re-examine a subject within too short a period of time, especially since one subject was able to memorize all the Arithmetic problems and work them out at home, and as a consequence, obtain a perfect score on this subtest when retested under the drug.

2. Subjects

The population of this study consisted of 9 male and 12 female, paid, non-psychotic volunteers whose ages ranged from 22 to 43. The median age was 29. The mean Full Scale *IQ* was 122.9 and the *IQ*s ranged from 100 to 136. Twelve subjects were graduate students: of these, eight were in fields allied with psychology, two were in teaching, one in law, and one in journalism. Four subjects had completed college or graduate school and were employed as bacteriologist, chemist, mechanical engineer, and teacher. Of the five remaining subjects one had completed nursing school, two had two years of college, one had business school training beyond high school, and one had completed grammar school. Occupationally, this latter group consisted of three housewives, one hairdresser, and one bookkeeper. Eleven subjects were single, nine were married, and one subject was married prior to the *During* examination.

Although criticism may be levelled at this experiment for being top heavy as far as *IQ*s (see Table 1) and educational levels are concerned, it might be conjectured that the nature of the experiment appeared to be less frightening to needy college students than it was to other groups that were contacted for volunteers. It may also be noted that most of the studies reported above were performed on a similar type subject. In any event, the argument may be offered that these subjects would be better able to articulate their reactions and subjective feelings than those who were not as "sophisticated."

C. RESULTS

From an *IQ* range of 100 to 137 and a mean Full Scale *IQ* of 122.9 in the *Pre* records, the range in the *During* records extended from 89 to 136 and the mean Full Scale *IQ* was 111.8. These scores point up a drop of 11.1 points in over-all functioning and a shift from the superior category of intelligence to the high average group of the mean Full Scale *IQ*s.

Table 1 shows the *IQ* ranges, the number of subjects in each intellectual category, and the distribution in terms of dosage for both *Pre* and *During*

TABLE 1
INTELLECTUAL CLASSIFICATIONS OF *Pre* AND *During* SUBJECTS AND DOSE DISTRIBUTION IN MICROGRAMS

Classification	IQ Range	<i>Pre</i>			<i>During</i>		
		Total number subjects	Number receiving dose	Dose in micrograms	Total number subjects	Number receiving dose	Dose in micrograms
Dull normal Average	79- 90	0			1	1	100
	91-110	4	4	100	8	6	100
						1	150
						1	200
High average	111-119	3	2	100	6	1	50
			1	150		5	100
Superior	120-127	6	1	50	3	1	50
			5	100		2	100
Very superior	128 and up	8	2	50	3	1	50
			5	100		2	100
			1	200			
Distribution of dosages received							
		Number of subjects		Dose received			
		3		50			
		16		100			
		1		150			
		1		200			

groups. This table also indicates that with four subjects falling in the average category of intelligence, three in the above average group, six in the superior, and eight in the very superior levels of intelligence, that the higher classifications are more heavily represented in this study. It also points out that 16 or at least $\frac{3}{4}$ of our subjects were given 100 micrograms. Three received 50 micrograms, one received 150 micrograms, and one 200 micrograms. The shift that has taken place in Table 1 in the *During* group is quite significant. The *IQ* scores now fall much more heavily in the lower categories. One subject's score fell in the dull normal group, eight scored in the average range, six in the above average, three in the superior, and three in the very superior classification.

Table 1 also shows the dose distribution. Of the eight *Pre* subjects in the very superior range, two received 50 micrograms, five received 100 micrograms, and one received 200 micrograms. Only one of the two subjects who received 50 micrograms and two of the five who had 100 micrograms still remained at this level.

In the superior range, the subject who received 50 micrograms maintained her level, but only one subject out of the five *Pre* subjects who got 100 micrograms remained in this category while another subject fell from the very superior group to the superior level.

The three subjects who scored in the high average category in the *Pre* group all fell to the average category under the drug. The 50 microgram subject now in this category scored in the very superior level without the drug. Of the five who had received 100 micrograms and now obtained high average scores, two were in the very superior and two were in the superior *Pre* categories. The remaining 100 microgram subject scored two points higher in the *During* Wechsler-Bellevue to advance out of the average group.

All of the four subjects in the *Pre* average group received 100 micrograms. Two remained at this level although decreases of 10 and 13 *IQ* points occurred in their *During* Wechsler-Bellevue tests. One subject, already noted, advanced to the above average category, and one subject fell to the dull normal category with a Full Scale *IQ* drop from 100 to 89. Of the four additional subjects at 100 micrograms in the *During* group, two were formerly in the superior and two in the high average groups. The 150-microgram subject in the *During* group was formerly in the high average category while the 200 microgram subject was formerly in the very superior category.

To summarize, seven subjects showed no shift, while of the 14 subjects that did shift from one category to another, only one moved upward and

that was because of two *IQ* points. The other 13 moved downward with an average drop of two categories per subject. Of the 11 subjects re-examined with Scale I, five subjects showed a drop in categories and six remained at their level. Of the 10 subjects retested with Scale II, eight subjects showed a drop in categories, one remained at his level, and one advanced. The smaller number of subjects falling to lower intellectual categories on Scale I might suggest that this scale is easier than Scale II or that previous experience might have mitigated the drug effect. The average number of intellectual categories that these subjects moved through was 1.4 for Scale I and 1.6 categories for Scale II.

Table 2 presents the statistical results of the comparison between *Pre* and *During* test scores. From these figures, it is obvious that LSD-25 does

TABLE 2
COMPARISON OF *Pre*-TEST AND *During*-TEST SCORES: $N = 21$

	Mean difference	Standard deviation of the difference	Standard error of the mean difference	t ($df = 20$)	Probability of chance occurrence of difference
Information	1.00	1.97	.43	2.33	.05
Comprehension	1.67	2.18	.48	3.48	.01
Digit Span	.81	2.32	.51	1.59	>.10
Arithmetic	3.19	4.44	.97	3.29	.01
Similarities	1.86	2.90	.63	2.95	.01
Verbal Scale <i>IQ</i>	10.14	8.48	1.85	5.48	.01
Picture arrangement	1.81	3.24	.71	2.55	.02
Picture completion	.95	1.75	.38	2.50	almost .02
Block design	2.48	1.96	.43	5.77	.01
Object assembly	.43	2.68	.59	.73	>.10
Digit symbol	2.48	2.79	.61	4.07	.01
Performance scale <i>IQ</i>	9.43	11.90	2.60	3.63	.01
Full scale <i>IQ</i>	11.00	9.80	2.14	5.14	.01

produce very significant differences in intelligence or intellectual functioning. In the comparison of the mean difference (*MD*) between Full Scale *IQ*s, Verbal Scale *IQ*s, and Performance Scale *IQ*s, we obtain *MD*s of 11.0, 10.14, and 9.43 respectively. *MD*s this large would be expected on the basis of pure chance to occur in only one such comparison of groups of this size in 100. Further, it may be noted that five out of the 10 subtests have *MD*s sufficiently large to produce results that are significant at the .01 level of confidence. These subtests are, Comprehension, Arithmetic, Similarities, Block Design, and Digit Symbol. While the 1 per cent level may be considered a rigorous criterion for a population of this size ($N = 21$, $df = 20$),

the fact that the *MD* of the Picture Arrangement scores is significant at the 2 per cent level, and the *MD* of Picture Completion scores almost reaches the 2 per cent level of significance, cannot be overlooked. Comparison of the *MD* between the Information subtests produces a *t* ratio that is significant at the .05 level of confidence which indicates that one could expect an *MD* this large in such a comparison of this size five times out of 100. The Digit Span *MD* is not significant at the 10 per cent level and the *MD* of the Object Assembly scores is clearly not significant.

D. DISCUSSION

Bearing in mind that (a) our subjects for the most part received higher dosages than the subjects of the studies reported on previously, and (b) that the experimental designs were different, the attempt will be made, nevertheless, to compare our results with those of the other studies.

First, there is a lack of agreement with the findings of both Rinkel, DeShon, Hyde, and Solomon as well as with Savage. They report that intellectual functioning was not disturbed, while this experiment shows that a clear-cut overall impairment in the utilization of basic intelligence occurred. This may well be a factor of dosage although Savage (6) does report dosages as high as 100 micrograms of LSD-25. It must be noted, however, that he started with 20 micrograms and increased the dosage daily until a definite psychophysical effect was observed, and that he apparently attempted to test his subjects before the drug had taken effect. The effects of daily consumption of this drug have not been fully evaluated as yet, and this variable may have influenced his results. As stated previously, Rinkel *et al.*'s (5) study was primarily of a clinical psychiatric nature, and, consequently, there is no data available for comparison.

However, in his study, Savage goes on to report difficulty in concentrating and no impairment in memory or in comprehension. We also found as did Condrau (2), that subjects experienced considerable difficulty in concentrating. But our data, while disclosing no significant impairment in recall, points out that comprehension or judgment is significantly disturbed. In the latter finding we differ with Stoll's (8) report as well.

Our results agree with Gastaut *et al.*'s (3) statement that abstract thinking is impaired. But in contrast to Gastaut, our sample shows up significant disruption of attention span as measured by the Wechsler-Bellevue test. It does show, however, in agreement with Condrau, that distractibility did increase.

The findings of this experiment indicate that the level of intellectual func-

tioning of our population was very significantly reduced. Interestingly enough, only the Digit Span and Object Assembly subtests were not significantly affected, although there is a suggestion that a larger sample might show a greater significance in Digit Span as well. In any event, Digit Span (which gives us a measure of recall as well as of ability to attend and, therefore, freedom from distractibility), and Object Assembly (which is a visual-motor test involving the recognition of familiar objects and the perception of relationships) are subtests of the Wechsler-Bellevue Test that are most highly vulnerable to the encroachments of anxiety. Thus, it would appear that anxiety was not a primary disrupting cause in the reduction of our subjects' level of intellectual functioning in structured situations.

Yet, our subjects' ability to concentrate, as measured by the Arithmetic subtest, was disturbed and this in turn adversely affected performance in almost all areas. Further, their performance on Digit Span does show some suggestion of distractibility since it is close to the 10 per cent level. In this context, that is, of impaired concentration and increased difficulty in attending, we can account for the big drop in Picture Arrangement scores. The latter scores reveal the considerable difficulty these subjects experienced in being able to observe the various nuances involved in inter-personal relationships in order for them to be able to understand, anticipate, and plan adequately in social and sexual situations. The Comprehension subtest (which measures the ability to exercise good judgment or "common sense" by noting if one can respond to various situations in a socially-conventional and expected manner) is also very significantly reduced. These findings emphasize the developing culturally out-of-tune status of our subjects under the influence of the drug. Their greatly lowered performance on Picture Completion throws this loss of former high level contact with the world about them into sharper focus. This subtest shows to some degree the amount of interest (or libido) directed towards the external world and away from the self, since it involves being able to differentiate essential from unessential details of objects within the environment. In this setting these data suggest that the subjects tended to withdraw and to become self preoccupied under LSD-25.

The very significantly lowered Similarities and Block Design scores clearly reveal that our subjects' ability to abstract, conceptualize, and synthesize was considerably lowered under the drug. Digit Symbol scores were also very significantly reduced. Digit Symbol provides us with a measure of one's ability to shift set or of one's flexibility. While the ability to recall accumulated knowledge, as measured by the Information subtest scores, was not as

significantly impaired as other subtests, it was definitely upset. This may also be due to the withdrawal of interest and concern with the self noted above. While not fully substantiated because of the well retained Object Assembly scores, the very strikingly significant statistical results obtained from the Block Design and Digit Symbol scores permit the speculation that depressive factors had produced motor retardation in these areas.

The conjecture may be made that smaller dosages of LSD-25 would undoubtedly be much more effective if this drug were to be used as an aid in therapy because of the (a) degree of impairment of abstractive and conceptualizing abilities, (b) difficulty in concentration, (c) loss of contact with the environment, (d) rigidity seen in their difficulty in shifting set, and (e) learning difficulty such a patterning indicates. This finding is in agreement with the findings of Abramson (1), and Levine, Abramson, Kaufman, Markham, and Kornetsky (4).

Nevertheless, an important factor that must be taken into consideration when a more suitable dosage for therapy is sought, lies in the Arithmetic-Digit Span relationship. In the *Pre* records, the Digit Span scores were, as most commonly found, below those of Arithmetic. In the *During* records, we find that a reversal has taken place. This uncommon or out-of-pattern relationship of Digit Span higher than Arithmetic has been found to indicate the presence of blandness in the personality which often enables the individual to discuss even the most personal experiences and feelings freely and without apparent discomfort (7). It would appear that this type of experimentally induced blandness together with the increased focus on the self could serve as a very beneficial component in psychotherapy, especially in the treatment of the severely inhibited and repressed. Consequently, the suggestion may be made that the optimum dosage would be one that would retain the ability to manifest this blandness quality, and yet not be large enough to wreak too much havoc with one's intellectual powers.

E. SUMMARY AND CONCLUSIONS

On the basis of 21 non-psychotic adults who were given the Wechsler-Bellevue Intelligence Scale in their normal state and then later under lysergic acid diethylamide, the following conclusions can be drawn:

1. Intellectual functioning was very significantly reduced.
2. Anxiety was not a primary disrupting factor of intellectual functioning in structured situations.
3. Concentration ability was disturbed.
4. There were suggestions of distractibility.

5. There were impairments in areas involving interpersonal relationships and judgment.
6. There was a disturbance of abstractive and conceptualizing abilities.
7. There was difficulty in shifting set.
8. An experimentally induced blandness of the type that has been found to permit a freer discussion of one's problems was noted.

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