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AN EXPERIMENTAL STUDY OF THE EFFECTS OF DEXEDRINE (D-AMPHETAMINE SULFATE) UPON MOTOR AND MENTAL PERFORMANCE AND SOME FACTORS IN MOOD

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INTRODUCTION

Several studies have been reported in the literature describing the psychological effects on human subjects of Benzedrine, a racemic mixture. These studies have been adequately reviewed elsewhere (Bartley and Chute, 1947). In general, these studies indicate increments in motor performance following administration of Benzedrine as measured by tapping speed, steadiness, and work on the finger and bicycle ergorgraph. With respect to mental functioning, this drug has been shown to increase intelligence test scores, achievement test scores, and ability to add six place numbers. No differences have been found due to Benzedrine on syllogistic reasoning ability and ability to do multiplication problems. With respect to mood, subjective reports of alertness, relaxation, lessened irritability, lessened fatigue, and euphoria have been given by subjects following doses of Benzedrine.

No similar studies to our knowledge have been undertaken, however, with the newer product Dexedrine (d-amphetamine sulfate). It was thought, in view of the fact that this substance is largely supplanting Benzedrine for therapeutic purposes, that a study investigating the effects of varying amounts of orally administered Dexedrine upon motor and mental performance and some factors in mood would be of interest.

METHODOLOGY

Sample. The sample consisted of thirty-six undergraduate students (18 men and 18 women) enrolled in Fisk University. The distribution of these subjects in the experimental design is described in Table 1.

Apparatus. The following tests were administered before and after the administration of Dexedrine.

1. *Whipple's Nine-Hole Steadiness Tester.* This device consisted of a metal plate mounted in an upright position and containing holes

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TABLE 1. *General design of experiment and number of subjects in each category*

SEX	GROUP	CONTROLS	10 MGM.	20 MGM.	TOTALS
Male	I	3	3	3	9
Male	II	3	3	3	9
Female	I	3	3	3	9
Female	II	3	3	3	9
Total	.....	12	12	12	36

varying in diameter from one-half to one-eighth of an inch. The subject was required to hold a stylus in each hole for 15 seconds. An impulse counter indicated each contact of the stylus with the edge of the hold. The subject's score was the total number of contacts for the nine holes.

2. *Tapping Board.* This board is made of a metal plate five inches square which is connected in a series circuit with an impulse counter and a stylus. The subject was given two trials of thirty seconds each and was instructed to tap the plate with the stylus as many times as he could within the time allowed. His score consisted of the total number of taps within the time limit for the two trials.

3. *Block Designs.* This test, widely used in standard intelligence tests (Kohs, 1937), utilizes blocks which can be manipulated to form designs. The spatial factor in intelligence is probably the main factor involved in performing this task. Two forms of this test were used. Form I consisted of Kohs' designs 1, 3, 5, 7, and 11, and Wechsler's (1944) designs 3 and 5. Form II consisted of Kohs' designs, "sample," 2, 4, 6, 8, and 10, and Wechsler's design 6. Wechsler's designs A and B. were used for demonstration purposes. These two forms were equivalent in terms of length and number of blocks required to complete each design but, as a precaution, the subjects were given this test in a confounded design (one-half the subjects received Form I in the pre-Dexedrine session, followed by Form II; and one-half the subjects received Form II during the first session, followed by Form I). This test was administered individually following Wechsler's instructions. The subject's score was the number of designs successfully completed within the time limits set by the authors of these tests.

4. *Questionnaires.* Two standardized tests were utilized to construct two forms of a questionnarie, which was administered, like the Kohs designs, in a confounded design. Form I consisted of the odd items from Parts III, V, and VII of *The Personal Audit* (Adams and Lepley, 1945). Part III of this test purports to measure the dimensions tranquility-irritability; Part V measures the dimensions stability-instability; and Part VII purports to measure the dimensions steadiness-emotionality. Those items in the *Minnesota Multiphasic Personality Inventory* (Hathaway and McKinley, 1943) which con-

tribute to the D (depression) or Ma (hypermania) scales were also utilized.

The items were randomized and every odd item placed in Form I. Form II of the questionnaire contained the even items from each test. These items were scored according to the standard directions of the authors.

5. *TAT Pictures.* A final test consisted of having the subjects write themas based on the Thematic Apperception Test pictures (Murray, 1943). It was thought that the subjects might project their mood into the stories which they were writing; *i.e.*, whether depressed or elated. Form I consisted of TAT pictures 1, 5, 11, 14, and 19; while Form II included pictures 4, 10, 13 MF, 15, and 20. This test was administered similarly in a confounded design. The themas were rated from 0-10 on a scale of happy-unhappy by three raters independently. The scores for this test consisted of the combined ratings.[3]

Procedure. The subjects were first pre-tested on the above mentioned instruments according to the confounded design. One week later, twelve subjects (six men and six women) were given 10 mgm. of Dexedrine in solution, per 150 pounds of body weight; six men and six women were given 20 mgm. of Dexedrine per 150 pounds of body weight; and a control group of six men and six women were given a placebo. The drug and the placebo were administered orally. One and one-half hours following the administration of the drug (after this period of time the effect of the drug was assumed to be at a maximum) the subjects were again tested on the above-mentioned instruments. None of the experimenters of subjects knew which subjects were in the experimental groups. The subjects did not follow any particular order in taking the tests, as the testing was done "cafeteria style," according to the preference of the subjects. Following completion of the experiment, the subjects wrote a subjective report of their feelings at that time.

Treatment of Data. To determine whether differences in the means of the columns "control," 10 mgm., and 20 mgm. were really due to the effects of the drug and not merely due to chance variations in the population used, required some test of significance. An analysis of variance technique was used as such a test. The score obtained by each subject on each test in the pre-Dexedrine session was subtracted from his score during the post-Dexedrine testing. These differences constituted the data. The total variance was the sums of squares of all these differences. The amount of variance which existed between the columns (Dexedrine) and as a function of other

[3]The reliability of the individual raters was determined by having them re-rate a group of thirty-six stories one week after the first rating. Rho was computed for Rater A as being .85; Rater B, .94; and Rater C, .91. The inter-rater reliability was determined by computing Rho between each of the three raters, using the stories from one TAT picture. Rho between Raters A and B was .74, betwen A and C, .84, and between B and C, 89.

identifiable factors such as groups and sex and their interactions with one another were subtracted from this variance total. This residual variance constitutes random variability within the population studies. The variance ratios are a comparison of this random variability with the variance which can be attributed to the other identifiable factors-Dexedrine, groups and sex (Snedecor, 1946).

Results

The analysis of variance carried out in the manner just described on all of our measures indicates that there were no significant differences on any of our tasks as a function of the amount of Dexedrine ingested. Table 3 presents a summary of the F values obtained from these analyses. It will be noted that there were significant differences between some of the forms of the tests which were used, but since forms were confounded in this design, the results are not affected. Table 3, together with Table 2, indicates that the sexes reacted differentially on the scale tranquility-irritability to different amounts of Dexedrine. Table 4 presents in tabular form the mean decreases in irritability scores of the various groups. While 10 mgm. of Dexedrine caused a large decrease in irritability among males, this was accompanied by a much smaller decrease among females. The converse was true when 20 mgm. of Dexedrine was given. The males had a smaller decrease in irritability, while the females showed a correspondingly larger increase. Table 3 also indicates a sex difference from pre- to post-testing with respect to the Depression scale. This, however, does not seem to be a function of Dexedrine, since the interaction term, Dexedrine X Sex, is not significant.

TABLE 2. *An analysis of variance of the effect of Dexedrine on tranquility—irritability*

Source of variance	Degrees of freedom	Sum of squares	Variance ratio	Probability
Total	35	1,730.	.....	.....
Dexedrine	2	50.2	1 –	.....
Sex	1	36.	1 –	.....
Dexedrine X Sex	2	429.1	5.89	.01
Groups	1	100.	2.75	.....
Dexedrine X Groups	2	147.1	2.02	.....
Sex X Groups	1	21.8	1 –	.....
Error	26	945.8	.....	.....

Table 5 presents a summary of the subjective reports given by our subjects. This summary shows that while four subjects in the control group and five subjects in the 10 mgm. group reported that they felt the "same" or "normal", only one person in the 20 mgm. group said he felt the same. Five subjects in the 20 mgm. group noted feelings of nervousness as compared with only one subject in the 10 mgm. and one subject in the control group. Also, five subjects

TABLE 3. *Summary of variance ratios obtained by analysis of variance of the various tasks used*

Task	Dexedrine	Sex	Interaction: Dex. X Sex	Groups	Interaction: Dex. X Groups	Interaction: Sex X Groups
Steadiness	1 –	1.12	1 –	.....	.....	.....
Tapping speed	1 –	1 –	1 –	.....	.....	.....
Block designs	1 –	1 –	1 –	15.15*	1.97	1.09
Tranquility—Irritability	1 –	1 –	5.89*	2.75	2.02	1 –
Stability—Instability	1.12	1 –	2.78	1.91	1 –	1 –
Steadiness—Emotionality	1.41	1 –	1 –	4.79†	1.91	1.59
Depression Scale	1 –	5.09†	1 –	20.36*	2.80	1.42
Hypermania Scale	1 –	3.72	1 –	1 –	1 –	1 –
TAT Stories	1.34	1.27	1.43	23.10*	1 –	1.10
F value required for significance at 5% level of confidence	3.37	4.22	3.37	4.22	3.37	4.22

*Significant at 1% LOC.
†Significant at 5% LOC.

in the 20 mgm. group made mention of the fact that they felt more alert, while only one subject in the 10 mgm. group and no controls indicated such a feeling. In the 20 mgm. group, two subjects observed feelings of "numbness" in their extremities, one subject stated that his speech felt "sluggish", and one subject reported that he felt "confused". In the 10 mgm. group one subject recorded feelings of being depressed and dizzy. There were no similar reactions among the controls. The all-over picture reveals a pattern of increasing complexity of subjective report with an increase in Dexedrine.

TABLE 4. *Mean decreases in irritability of males and females under different conditions of Dexedrine*

SEX	CONTROLS	10 MGM.	20 MGM.
Males	−11.1	−12.5	− 8.4
Females	−12.9	− 8.9	−13.2

DISCUSSION OF RESULTS

One of the more interesting of our findings is that there were no differences in motor or mental performance which could be directly attributed to Dexedrine. While we have no studies utilizing Dexedrine with which to compare our findings, several studies have been undertaken in the past utilizing Benzedrine. Thornton, Holck, and Smith (1939) utilized two of the tasks which we used, tapping speed and steadiness, and found significant improvement when the tasks were preceded by 20 mgm. of Benzedrine. This difference in findings may be due to the fact that they used tasks much longer in length than our own, and their study was carried out over a longer period of time. Thus, while our study is designed to measure immediate effects, where fatigue and other variables may have been factors influencing performance.

With respect to mental functioning, we have a somewhat confused picture of the effectiveness of Benzedrine in this area. Sargeant and Blackburn (1936) found small increases in intelligence test scores as did Molitch and Eccles (1937). Whether these differences are significant is debatable as no tests of significance were used in either case. Andrews (1940) found no reliable differences in syllogistic reasoning following 10 mgm. of Benzedrine, and McNamara and Miller (1937) found no reliable differences in the speed or accuracy with which subjects completed multiplication problems. These studies are of interest because while they all used different tasks, they all measured aspects of mental functioning. The results of the present study tend to be in line with those of Andrews and McNamara, and of Miller. It may be noted that these two latter studies used tasks which are about the length of our block designs series. The difference between the present results and the findings of Molitch and Eccles, and Sargeant and Blackburn may be due to the fact that their tasks were also longer than our own.

TABLE 5. *Summary of subjective reports of the three groups*

	Same Normal	Elation	Tired	Nervous	Alert	Drowsy Sleepy	Other	Total Responses
Controls	4	0	2	1	0	3	2	2
10 mg....	5	2	2	1	1	0	4	5
20 mg....	1	2	3	5	5	2	8	7

Most of the studies appearing in the literature report definite experiential effects even when there are no other significant differences in performance (Myerson, 1936; McNamara and Miller, 1937; Barmack, 1938). The present investigation indicates that such experiential differences do exist, as indicated by subjective report, as a function of the amount of Dexedrine ingested. However, our tests, including a modification of a projective technique, did not show any changes. This outcome suggests that the immediate effects of Dexedrine on mood, if they exist, are subtle ones and that the instruments which we used are not sensitive enough to detect these changes.

Summary

Thirty-six (36) subjects were administered tasks designed to measure mental and motor performance and some factors in mood. Twelve (12) subjects were given 20 mgm. of Dexedrine orally; twelve (12) subjects received 10 mgm. of Dexedrine; and twelve (12) subjects (who were given a placebo) served as controls. Between pre- and post-Dexedrine testing no differences were found in mental or motor performance which were directly attributable to Dexedrine. However, it was found that while differences in subjective report seemed to exist, there were no differences in mood as measured by the questionnaire methods and by the evaluation of stories written in response to standard stimuli (TAT cards).

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