DRUGS AND PERSONALITY

II. THE EFFECT OF STIMULANT AND DEPRESSANT DRUGS ON CONTINUOUS WORK

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INTRODUCTION

IN a previous paper one of us (4) has elaborated a theory relating drug action to personality. According to this theory, depressant drugs increase cortical inhibition (Pavlov) or reactive inhibition (Hull), thus producing an *extraverting* effect on personality, while stimulant drugs decrease inhibition and produce an *introverting* effect in behaviour. It was also suggested in this paper that a direct proof of the hypothesis might be obtained by making predictions regarding the effects of stimulant and depressant drugs on a variety of experimental laboratory situations connected with the general theory of inhibition and excitation.

When this theory is applied to what is often called the *work decrement*, i.e. the decrease in performance under conditions of continuous exertion, we may predict that (1) depressant drugs, by increasing inhibition, will lead to a more rapid and a more marked work decrement than would a placebo, and (2) that a stimulant drug, working in the opposite direction, would lead to a less rapid and less marked work decrement than would a placebo (4). There is some evidence in the literature supporting this hypothesis, particularly the excellent studies by Payne and Hauty (7, 8). In one of their experiments involving 144 subjects who had received preliminary training on a complicated compensatory pursuit task involving simulated aircraft instruments, and were then made to work continuously for four hours, it was found that dextro-amphetamine sulphate was singularly effective in minimizing work decrement, while a mixture of hyoscine and diphenhydramine hydrochloride hastened and maximized it. In another study, using 168 subjects who performed for 7 hours on a similar task, they found that dextro-amphetamine sulphate and caffeine effectively mitigated work decrement, while benadryl hyoscine had the opposite effect. All these results were highly significant statistically.

According to our theory, feelings such as boredom, fatigue, sleepiness, and so forth are the introspective concomitants of cortical inhibition (6). In terms of translating this theory into the drug field, we would expect such subjective feelings to *decrease* after the administration of stimulants and to *increase* after the administration of depressants. This deduction has been verified by several writers, in particular Barmack (1). He summarizes his work

* We are indebted to the Bethlem Royal and Maudsley Hospital Research Fund for support which made this study possible.

by saying: "The interpretation is favoured that the effect of the benzedrine . . . is principally on the inclination rather than on the ability to do continuous repetitive work." This conclusion is in line with the Hullian notion of inhibition as a drive, and consequently the growth of a negative drive or "disinclination" as a result of continuous practice.

In view of what is known about the growth of reactive and conditioned inhibition, we would expect stimulants to be effective after some time rather than immediately. This follows from the simple consideration that their ability to decrease inhibition is dependent on the previous growth of inhibition; during the early stages of practice little inhibition has been developed and the drug, therefore, cannot show any considerable effectiveness in overcoming inhibition. Again, Barmack has shown that this deduction is verified. Here is a typical quotation from his work, summing up his results on continuous adding: "The differences in rate of work obtained for the two conditions (placebo versus drug) were negligible at the beginning, and most striking at the end of the work period." The work summarized in these few references certainly appears to be in line with the predictions from our theory; a more systematic review is given elsewhere (4, 6).

THE EXPERIMENT

The experiment reported here is on a somewhat less heroic scale than that of Payne and Hauty, involving considerably less than 7 hours' continuous work. The apparatus used was the so-called *pursuit rotor*, consisting of a bakelite turntable into which a small metal disk is set near the circumference. This disk turns with the turntable, describing a circle in front of the subject who holds an articulated metal rod in his preferred hand, which he tries to keep in touch with the metal disk for as much of the time as possible. Electric clocks enable the experimenter to note the percentage of time that the subject is "on target" during successive 10-second periods. The instrument used and the instructions given have been reported previously in connection with another experiment (2).

The experimental conditions also duplicated those of our previous experiment. Five minutes of consecutive practice were followed by a 10 minutes' rest, a second 5 minutes' continuous practice, a second 10 minutes' rest and a third 5 minutes' practice period. The rest periods were included in order to allow the measurement of reminiscence phenomena. Briefly, the term reminiscence refers to the dissipation of reactive inhibition accumulated during continuous work, which takes place during a rest pause; this dissipation of inhibition is shown in performance by an improvement following the rest pause. It is measured by subtracting the last score before the rest period from the first score after the rest period. (Further details regarding the analysis of learning curves of this kind in terms of inhibition and reminiscence can be found in a previous paper (3).)

The subjects for the experiment were university students, all female; these were allocated at random to the four experimental groups. Group A, consisting of 18 subjects, was administered 10 mg. of dextro-amphetamine sulphate approximately 75 minutes before the beginning of the test. This group will be referred to as the "short dexedrine" group or D*S* group to distinguish it from group B, consisting of 15 subjects who were also administered 10 mg. of dextro-amphetamine sulphate, but who did not begin the test until at least 250 minutes had elapsed after the administration of the drug. This group will be known as the "long dexedrine" or D*L* group. The 18 members of the third group were

administered 4½ grains of sodium amylobarbitone, while the 18 members of the fourth group were given a placebo. All subjects taking part in the experiment were also administered the Maudsley Personality Inventory, a questionnaire measure of neuroticism and of extraversion (5).

The following predictions were made:

1. Total performance will be highest under dexedrine, lowest under amytal, and intermediate under placebo conditions. The reason for this prediction has already been given in the introduction. It will be noticed that no differential prediction is made with respect to the two dexedrine groups; a perusal of the literature concerning this drug did not make it possible for us to say which of the two periods would be the more effective.

2. Differentiation between the groups on the basis of drug effects will be a function of time in the sense that it will be determined (*a*) by the length of time during which continuous work takes place, thus generating reactive inhibition, and (*b*) by the length of time elapsing from the administration of the drug to the beginning of the work periods which are being studied.

Results

In Figure 1 are shown the scores of our four groups during the course of the experiment; 30-second trials have been plotted instead of 10-second trials in

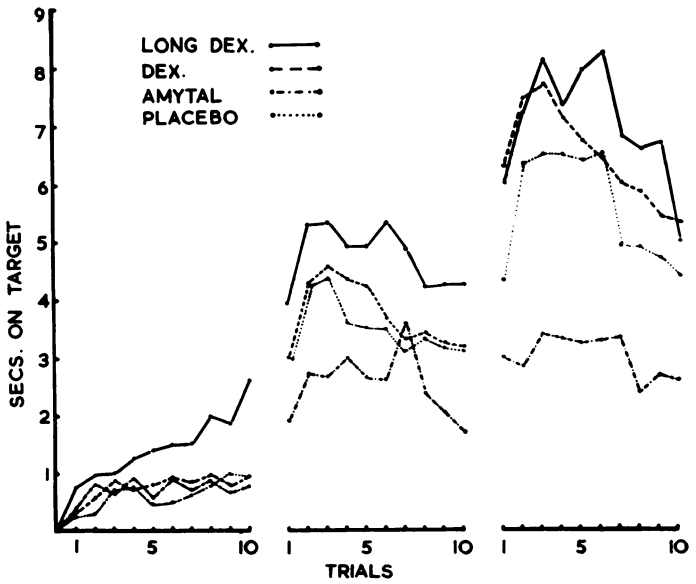

FIG. 1.—Performance on pursuit rotor during 3 five-minute periods of continuous work of three drug and one placebo groups. Seconds on target are plotted against 30-second periods.

order to make the curves less irregular. (No additional information would be conveyed if the more detailed curves had been given.) It will be seen that during the first 5-minute period the only group which deviates considerably from the others is the D*L* group; as predicted, subjects in this group performed at a considerably higher level than placebo and sodium amytal subjects. During

the second 5-minute period the D*L* group is clearly the most productive, but now the amytal group has also become separated out and is clearly the least productive. The placebo and the D*S* group are still very close together and cannot be differentiated. During the third period the amytal group is very much the least productive, with the placebo group intermediate and the D*L* group at the top as before. This time, however, the D*S* group has also improved and overlaps with the D*L* group. Results seem to be very much in accordance with anticipation in so far as predictions 1 and 2 are concerned.

TABLE I

Source of Variance	Sum of Squares	df.	M.S.V.
Total	1255·1621	2,069	
Periods	728·0618	2	364·0309
Treatments	103·5507	3	34·5169
Period/treatment interaction	34·0668	6	5·6778
Residual	389·4828	2,058	·189253

Table I presents an analysis of variance of the results. As might have been expected, the difference in performance between the periods is very highly significant. So is the significance of the treatments, a result which verifies our first prediction at an acceptable statistical level. Also highly significant is the period/treatment interaction, a result which substantiates our second prediction at an acceptable level of significance. We may conclude therefore, that the drugs used have differential effects on performance, that these effects are in line with prediction and that they interact in complex ways with stage of practice and/or time elapsed since administration. (The former effect is probably the more important, as the total time taken up by the experiment is not very long—35 minutes. However, a separate experiment would be required to settle this problem decisively.)

(It may be mentioned in parenthesis that the randomization of our sample appears to have been adequate, because on starting scores, on extraversion scores, and on neuroticism scores analysis of variance failed to find any difference between the four groups which even approached significance.)

As in our theory stimulant drugs have *introverting* effects, while depressant drugs have *extraverting* effects, it may be of some interest to compare the results shown in Figure 1 with the performance of the 10 most introverted and the 10 most extraverted subjects out of a group of 50 students tested without drugs on this apparatus, under comparable conditions (2). Figure 2 gives the

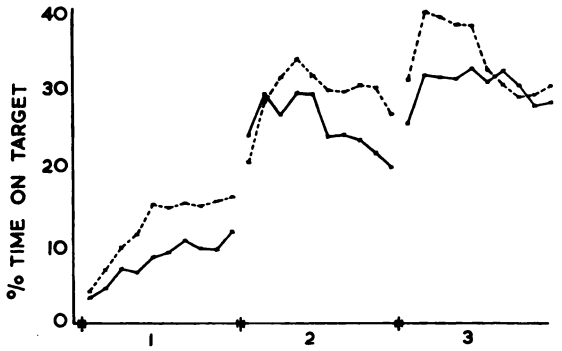

FIG. 2.—Performance on pursuit rotor during 3 five-minute periods of continuous work of 10 introverted (broken line) and 10 extraverted (solid line) subjects. Per cent. of time on target is plotted against 30-second periods.

detailed information; the points of similarity will be obvious. The introverts, like the dexedrine group, achieve an early superiority over the extraverts, or the amytal group; this superiority is sustained throughout most of the experiment. The differences between the two figures, such as the final equality of scores of extraverts and introverts in Figure 2, Period 3, are due to factors such as conditioned inhibition which are expected in terms of learning theory to play a part in the development of the reaction potential ($_{s}E_{R}$), but which may not be affected by drugs in ways which can at present be predicted. There is much room here for further extension of our theory to other concepts in the field of learning theory.

SUMMARY

Two hypotheses were experimentally tested regarding the effects of stimulant and depressant drugs on continuous work. These predictions were made: (1) Depressant drugs will lower performance while stimulant drugs will increase performance as compared with the level of the placebo group. (2) There will be differential action of drugs over time due to the relatively slow build up of inhibition, and/or the increase in time of test since drug administration. Both predictions were verified at a high level of statistical significance. On the whole, the results of the experiment supported the general theory of drug action put forward.

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