EXPERIMENTAL STUDIES OF THE MENTAL SPEED OF SCHIZOPHRENICS

I. EFFECTS OF A STIMULANT AND A DEPRESSANT DRUG

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INTRODUCTION

IT has been clinically observed that psychiatric patients in general (6, 11) and schizophrenic patients in particular (1, 4) show abnormalities of mental speed, being "retarded" or slower than normals on many measures. Confirmatory evidence on this point is to be found but much of the early work on speed of schizophrenic reactivity used measures of speed of motor performance (12, 13) or of reaction time under various conditions (6), ignoring more fundamental slowness of thought processes. The present studies are concentrated on the recent finding that schizophrenics show abnormally slow *mental* speed measured in a problem-solving situation (4, 18, 19). The aim of the investigation was to discover the exact conditions under which this abnormality appears, and, thence, by manipulating the experimental conditions, to be able to bring speed of mental functioning under experimental control. This paper describes the attempt to bring speed under control by means of drugs. A second paper (2) deals with the effect of practice upon mental speed.

Layman (15) conducted an intensive study to measure the changes reported to take place in schizophrenics under the influence of sodium amytal. An improvement in intellectual performance (on the Binet test) was reported. Other workers (17) report an increase in Wechsler Verbal Scale score for schizophrenics with amytal. These, and studies on effects on motor speed, have been repeated elsewhere, but the study of intellectual speed has been largely neglected. One of the few studies in the field is that of Ogilvie (19) who found that amytal improved the speed of problem solving of a group of schizophrenics, while the drug decreased speed of working in a control group of normals.

Osgood (20) suggests that depressant drugs slow down the rate of acquisition of a conditioned response and increase the rate of extinction (10), while the reverse is true of central excitants. Many studies support this suggestion, though only dealing with one type of drug. Thus, Steinberg and Summerfield (27) show that a depressant decreases the rate of acquisition of associations. Despite these suggestive leads from the literature, a survey serves only to indicate the general lack of planning of research on the psychopharmacology of depressant and excitatory drugs. The following experiment was therefore carried out to determine the effects of a central depressant (sodium amytal) and a central stimulant (dexamphetamine sulphate) upon problem-solving speed of schizophrenic subjects.

The literature suggested the following predictions:

1. Central depressants: increase the mental speed of schizophrenics;
   decrease the speed of normal persons;
   do not affect intellectual level of schizophrenics or normal persons.
2. Central stimulants: decrease the speed of schizophrenics;
   increase the speed of normal persons.

PROCEDURE

The subjects were schizophrenic patients of the Maudsley and Bethlem Royal Hospitals, and students of the Occupational Therapy Departments of the Hospitals. The patients were thus already a select group, not randomly chosen from the general mental hospital population, and the normal subjects were chosen to match them as closely as possible in age and intelligence. The diagnosis of schizophrenia was made by two consultants of the Joint Hospital and no subject was included about whose diagnosis there was any doubt. The patients showed at the time of testing or had shown in the recent past, at least one and more probably two or more of the major symptoms of psychosis found by Lorr, Jenkins and O'Connor (16) in their factorial analysis. Furthermore, the patients were not chronic mental patients, but were early schizophrenics. The period of hospitalization prior to testing varied from a fortnight to 13 months. The average age of the patient group was 25·6 years. Subjects of both sexes were investigated and the sexes were represented equally though there is no evidence that there is a sex difference in speed of mental functioning. The patients were of at least average intelligence as measured by the Nufferno Test of Level of intellectual functioning. They had not received any physical treatment during the six months prior to testing as there is mounting evidence that this has an effect upon speed (9, 14). No patient in the group had undergone psychosurgery, and those who were under a constant regime of drug treatment or sedation were excluded. All patients were rated A or B for co-operation, these being the highest categories on Shakow's (25) criteria.

Subjects were tested individually using the Nufferno Tests of Mental Speed and Level (4, 7, 8). The former gives time scores (mean log. time) and the latter an accuracy score convertible to equivalent I.Q. There are three forms of the Speed Tests—forms AA and AB being parallel simple forms, and form B being more difficult.

A. *Effect of Central Depressant—Sodium Amytal*

The performance of twenty-three schizophrenic and seven normal subjects was investigated. The patients were divided into two groups—the drugged (fifteen) and the undrugged (eight). The latter were tested in the same way as the former but were given no drug. Each patient in the drugged group was tested on three consecutive mornings. On the second morning, each took 6 gr. sodium amytal in water. The drug was prescribed by the patient's physician and administered by a nurse of the ward at precisely 10 a.m. (in order to standardize the time interval between ward breakfast and ingestion of the drug).

The experimenter met the patient immediately after 10 a.m. each morning. On the first and third day testing commenced almost immediately. On the second day testing commenced when the patient spontaneously reported feelings

of psychological changes taking place, which occurred after periods ranging from 20 to 45 minutes with an average delay of 31 minutes.

It will be noted that the criterion of drug action is subjective. However, in the absence of such precise measures of sedation threshold as have now been developed (23, 24), it was decided to duplicate the procedure used by Ogilvie (19) who also observed no nystagmus or other physical signs with this dosage and was therefore forced to rely upon the patients' reports. In fact, the dose given was sufficiently large for every patient to report subjective impressions of the drug effect, and rapport was so good that prompt and accurate descriptions of these subjective feelings were forthcoming. Slurring of speech was observed in approximately one-third of the subjects.

Testing consisted of the Nufferno Level Test and Speed tests given on each of the three testing days.

B. *Effect of Central Stimulant—Dexamphetamine Sulphate* ("*Dexedrine*")

Sixteen schizophrenic subjects were chosen in the same way as for the amytal experiment. Results are also available from the group of seven normal subjects previously mentioned. As before, the patients were divided into two groups, drugged and undrugged. The control group was tested as the drugged group but no Dexedrine was given on the second day.

Each patient was tested on three consecutive mornings. At 10 a.m. on the second morning, those in the drugged group took 10 mg. Dexedrine in water. Conditions of administration of the drug and the psychological tests were as for sodium amytal. On the second day testing commenced when the patients spontaneously reported feelings of change, or, failing this, after 45 minutes had elapsed since ingestion of the drug. It was found that many subjects failed to show any effects of the drug and others failed to report subjective feelings attributable to it.

Testing consisted of the Nufferno Level Test given on the first day, and the Nufferno Speed Tests given on each of the three days.

Results

The results were analysed to determine whether or not there were significant differences in day to day performance as found by Ogilvie (19) and attributed by him to drug effect. Following his analysis, correlated *t*-tests, or *A*-tests (21), were calculated for each of the speed tests. He found significant increases in speed (decrease in mean log. time) at the 0·1 per cent. level (Test AA) and 1 per cent. level (Tests AB and B) from pre-amytal testing to testing under sodium amytal. In the present experiment using sodium amytal the patients were found to improve their scores from Day 1 to Day 2, significantly at the 1 per cent. and 5 per cent. levels for tests AA and AB respectively as shown in Table I.

When comparing results obtained on the second and third days, Ogilvie found decreases in speed. By contrast, the patients in the present experiment showed consistent increases in speed from Day 2 to Day 3, i.e. when sodium amytal was withdrawn. All increases are significant at the 5 per cent. level or beyond. Overall improvement from first to third days was significant for all three speed tests at least at the 1 per cent. level (Table I).

It is apparent, therefore, that Ogilvie's major finding is not confirmed by this study. The improvement in speed scores which he found on testing under

TABLE I

Comparison of Scores from Day to Day
Patients Drugged with Sodium Amytal on Day 2

Comparison	Time in log.-seconds: First Mean	Second Mean	Mean Difference	d.f.	*t* or *A*	*P*	Significance
Day 1-Day 2:							
Speed test AA ..	1·0692	0·9663	0·1029	7	4·5938	0·01>*P*>0·001	1%
Test AB ..	1·1102	1·0203	0·0899	14	0·2284*	0·05>*P*>0·01	5%
Test B	1·3485	1·3336	0·0149	7	0·7450	*P*>0·1	N.S.
Day 2-Day 3:							
Test AA ..	0·9663	0·8007	0·1656	7	3·7047	0·01>*P*>0·001	1%
Test AB ..	1·0203	0·8682	0·1521	14	0·2221*	0·05>*P*>0·01	5%
Test B	1·3336	1·2502	0·0834	7	4·7931	0·01>*P*>0·001	1%
Day 1-Day 3:							
Test AA ..	1·0692	0·8007	0·2685	7	6·3300	*P*<0·001	0·1%
Test AB ..	1·1102	0·8682	0·2420	14	0·1050*	*P*<0·001	0·1%
Test B	1·3485	1·2502	0·0973	7	3·5071	0·01>*P*>0·001	1%
	Level Test Score						
Level Test:							
Day 1–2 ..	446·4	482	35·6	14	0·2850*	*P*>0·05	N.S.
Day 2–3 ..	482	497	14·8	14	0·8420*	*P*>0·05	N.S.
Day 1–3 ..	446·4	497	50·6	14	0·1580*	0·01>*P*>0·001	1%

* *A*-values (21) which increase in significance as they decrease in size.

sodium amytal is indeed confirmed, but the crucial finding of a return to the original speed on withdrawal of the drug is not repeated here.

Present findings on the Nufferno Level Test are more in line with previous findings. The fifteen drugged patients showed a steady improvement in level from day to day. These improvements are not significant from any one day to the next but overall are significant at the 1 per cent. level (Table I). In a similar calculation Ogilvie found overall improvement in intellectual level of his schizophrenic patients to be significant at the 5 per cent. level.

In view of the discrepant findings—the present results not confirming those of Ogilvie on mental speed—a check was made on the statistical comparability of the groups of patients used in the two researches. The expectation that there were no significant differences between them in age, intellectual level, initial intellectual speed and variances of scores was in fact confirmed. Therefore, with the knowledge that the groups were comparable, further analyses were carried out to investigate the effect of the drug sodium amytal on mental speed of schizophrenics.

Improvement scores, that is, differences in mean log. times from one day to the next day, were calculated for the drugged patients and for the eight schizophrenic control subjects. A comparison of the improvements of these two groups (by uncorrelated *t*-test) showed no significant difference, as shown in Table II. Similarly, when the improvements of the drugged patients are

TABLE II

Comparison of Improvement Scores of Patients Drugged with Sodium Amytal, with Improvement Scores of Undrugged Patients

Comparison	Time in log.-seconds: Mean Improvement: Drugged	Undrugged	Mean Difference	*t*	Significance
Test AB: Day 1–2	0·0906	0·0597	−0·0309	0·3533	N.S.
Test AB: Day 2–3	0·0609	0·0613	+0·0004	0·0060	N.S.

compared with those of normals, in six comparisons there is only one significant difference (at the 5 per cent. level). Therefore, from these findings, no significant difference in improvements can be claimed in the day to day speed scores when drugged schizophrenics are compared with undrugged patients or undrugged normal subjects.

Examination of the data from the experiment on Dexedrine yielded similarly negative results. There was a consistent improvement in mean log. times for the drugged group from day to day on all three speed tests, as shown in Table III.

TABLE III

Comparison of Speed Scores from Day to Day, Patients Drugged with Dexedrine on Day 2

Comparison	Time in log.-seconds: First Mean	Second Mean	Mean Difference	*t* or *A*	*P*	Significance
Day 1–2:						
Test AA	0·8007	0·7171	0·0837	2·7900	$0{\cdot}05>P>0{\cdot}01$	5%
AB	0·8896	0·7636	0·1260	2·8188	$0{\cdot}05>P>0{\cdot}01$	5%
B	1·2503	1·1747	0·0756	2·2771	$P>0{\cdot}05$	N.S.
Day 2–3:						
Test AA	0·7171	0·6748	0·0423	1·4947	$P>0{\cdot}1$	N.S.
AB	0·7636	0·7250	0·0386	0·8042	$P>0{\cdot}1$	N.S.
B	1·1747	1·1096	0·0651	1·6285	$P>0{\cdot}1$	N.S.
Day 1–3:						
Test AA	0·8007	0·6748	0·1260	0·1822*	$0{\cdot}01>P>0{\cdot}001$	1%
AB	0·8896	0·7250	0·1646	0·2420*	$0{\cdot}05>P>0{\cdot}01$	5%
B	1·2503	1·1096	0·1584	0·2046*	$0{\cdot}02>P>0{\cdot}01$	2%

There are seven degrees of freedom throughout this Table.
* *A*-values, which are more significant as they decrease in size.

The predicted effect of Dexedrine upon speed of problem solving was not found, and we must conclude that the observed changes in speed scores from day to day are attributable, not to the drug, but to a practice effect.

Comparison of the results from the schizophrenic patients given Dexedrine with those from undrugged patients and normals gave no single significant difference in improvement. Examination of individuals' changes from day to day serve only to show that the effects of the drug Dexedrine on performance in problem-solving speed tests are random, while the overall result of continuous improvement due to practice remains to be investigated (2).

DISCUSSION

Dosing schizophrenic subjects, with 6 gr. sodium amytal orally, made no difference to their performance on the Nufferno Speed Tests though an improvement over the whole testing period of three days was observed which could be attributed to practice. Similarly, 10 mg. Dexedrine produced changes in the speed of problem-solving so variable that the only reasonable conclusion is that the effects of the drug are unpredictable. The possibility that the drugs were not in fact acting maximally when testing took place exists, but must be rejected. Testing commenced approximately half an hour after drug ingestion and continued about one and a half hours. The drugs therefore had ample time to become effective.

The further objection may be raised that the experimenter and physician were aware which drug had been given to a patient and when it was given. The study was not planned as a "blind" investigation of the drug effect. In view of the apparent lack of effect of the drugs this factor cannot be held to have influenced the results. Positive findings would have been more suspect and control for this factor would have necessarily followed the first experiments.

It would appear, therefore, unprofitable to continue to investigate drug effects upon intellectual speed. The brain, it seems, is resistant to change in terms of speed of mental functioning in response to both an excitatory and a depressant drug. Resistance to change in conceptual thinking of schizophrenics has also been noted with a mixture of sodium amytal and Dexedrine (22). Other authors agree on the lack of effects of various drugs upon psychological test scores (3, 26), but Franks and Laverty (5) report the opposite in the case of such a simple process as the conditioned eyeblink. Osgood (20) also mentions —with too meagre documentation—that drugs have been found effective in increasing and decreasing the acquisition of conditioned responses, cortical stimulants and depressants being found to have opposite effects.

There is, therefore, great need for further experimentation to show definitely whether or not there is, as suggested by the findings to date, a fundamental difference between simple and complex psychological functioning in changeability under drugs. An experiment comparing the effects of sodium amytal upon problem-solving speed and on conditionability would be of value.

The intrinsic interest, to the clinical psychologist, of the findings of no change in speed measures attributable to the drugs, must not be overlooked. In many situations, examination of a patient is cancelled or delayed, or psychological testing accepted without confidence when it is discovered that the patient is under sedation. The implication of our findings is that sedation is probably irrelevant to cognitive test results. Though there is already some confirmatory evidence on this point, further experiment is needed.

Finally, we may note an important implication of our failure to confirm the preliminary findings of Ogilvie (19) on the effects of sodium amytal on speed of mental functioning in schizophrenics. Isolated experiments with important theoretical and practical implications are too often accepted without question in psychological research. There is much need of repetition and confirmation or refutation of original work. In the present case, it may be pointed out that Ogilvie himself, in a second experiment, could not confirm his earlier results, but he attributed this failure to allowing inadequate time for the drug to take effect (19). In the light of the present findings, the more plausible hypothesis is that the first result was due to an artefact and the second is but further evidence of the real state of affairs.

SUMMARY

The effects of a central depressant, sodium amytal, and a central excitant, dexamphetamine sulphate, on speed of mental functioning in schizophrenics, were investigated. Twenty-three schizophrenics and seven normals were given the Nufferno Speed tests on three consecutive days. Fifteen patients were given 6 gr. sodium amytal prior to testing on the second day. Similarly, sixteen schizophrenic patients and seven normals were given the Nufferno Speed tests on three consecutive days. Eight of the patients took 10 mg. dexamphetamine sulphate prior to testing on the second day. Expectations that the depressant drug would increase schizophrenic mental speed and the stimulant decrease speed in these patients, were not confirmed. An improvement in speed scores from day to day was the most consistent finding with both drugs, and is attributable to practice.

The implications of the lack of drug effect are discussed and the need for repetition of experimental work is stressed.

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