The Operant Performance of Psychotics on Interval Schedules of Reinforcement

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THE OPERANT PERFORMANCE
OF PSYCHOTICS ON
INTERVAL SCHEDULES OF REINFORCEMENT

by
Patricia K. Sorensen

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
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Patricia K. Sorensen
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INTRODUCTION

A continual and efficient assessment of the environment is a primary determinant of appropriate behavior. If an individual becomes unable to effectively interpret the feedback he receives from the interaction of his behavior and the environment, his behavior may become "abnormal."

The free operant conditioning method developed by Skinner has succeeded in experimentally defining for lower organisms what may be termed the ideal and most efficient pattern of response given precise environmental conditions. An organism is placed in an experimentally controlled situation and his manner of responding is observed and recorded. The schedule on which the reinforcements are delivered can be manipulated so that the organism may vary his pattern of responding in order to receive the maximum number of reinforcers with the least effort.

In the behavioral study and treatment of mental illness the ability to define the parameters and characteristics of psychotic behavior is a major requirement. In an effort to objectify and measure the behavior of psychotics Lindsley and Skinner (1954) attempted to determine the applicability of operant conditioning
techniques in the experimental analysis of psychotic patients. They found that the performance of psychotics on a variable interval 1 minute schedule and a fixed ratio 20 schedule suggested that psychotic behavior is controlled "to some extent" by the reinforcing properties of the immediate physical environment, and that the "effects of different schedules of reinforcement upon behavior of psychotics should be investigated further (Abstract)."

Other studies further investigated the performance of psychotics on operant schedules of reinforcement. Lindsley (1960) found the majority of such patients to be characterized by low erratic rates of response. In a sample of 50, "only 10% responded at normally high and even rates of response with no pauses in the responding greater than 10 seconds in duration (Lindsley, 1962, p. 80)." These findings were corroborated by Ellis, Barnett and Pryer (1960), with mental defectives. They found that "the record of the severely defective S is particularly like that of the psychotic, i.e. containing frequent pauses (p. 68)."

Lindsley (1956) suggested that the counting and summing of all interresponse pauses greater than 10 sec could serve as an objective indicator of the frequency and duration of psychotic outbursts strong enough to interfere with a particular response. Lindsley further suggested that on the basis of interresponse times a
continuum of normal to severe individuals could be determined with normals at the low end (no interresponse time over 10 sec) and the severely disturbed patients at the high end. Thus, Barnett and Pryer (1960) reported that their data suggest that "this measure (sum of IRT greater than 10 sec) is related to intelligence level within a defective population (p. 67)." Lindsley distinguished between "patients who do not respond but take numerous breaks, and normals who take only an occasional short break (p. 14)."

Mednick and Lindsley (1958) conclude as a result of a study to examine the relationship between rate of response and severity of illness (as determined by rating on Lucerno-Meyer Fergus Falls Behavior Rating Sheet) that "the individuals (in a chronic group) who are high operant responders may be those who remain sensitive to the rewards in the social environment and can learn to manipulate the environment (p. 15)." They, therefore, suggest that a continuum of normal to severe psychotic individuals could be determined on the basis of the sum of the IRTs greater than 10 sec.

Kroeker and Oetting (1969) define the issue further by suggesting that responding appropriately on an operant schedule of reinforcement is essentially a problem solving process which demands certain behaviors regardless of the nature of the problem.
(1) S must assimilate as much information as possible during an initial period of inspection.

(2) He should generate a best guess or hypothesis as to the possible solution and proceed to make a careful first try.

(3) He then evaluates any forthcoming feedback.

(4) He must be willing to concede mistakes and change his hypothesis and behavior until feedback verifies his hypothesis (p. 724).

Kroeker and Oetting state that the basic question in the use of free operant conditioning with psychotics concerns the extent to which behavior is modifiable, i.e. to what extent does an individual have the ability to develop a new repertoire appropriate to the stimulus conditions of his environment. This, they maintain, can only be investigated by concentrating on the acquisition period of responding on a given schedule. Extensive work has been done toward understanding the parameters of ongoing behavior but Kroeker and Oetting believe that data on individual variations in patterns of responding are lost except for subjects who persist with extreme deviations. Over an extended period of time, as the control of a particular schedule becomes dominant, individual differences dissipate. Kroeker and Oetting maintain that the individual differences during the acquisitions phase are crucial to the analysis of the psychotic's ability to assess his environment. This concentration on the
acquisition period is supported by Lindsley's data. He found that when investigating the possibility of slow acquisition causing low rates of response on VI schedules, patients with extremely low rates were held on VI schedules for over one year of one hour per week sessions. Only 10% showed an increase in rate of responding and these still had an abnormally high rate of IRTs greater than 10 sec.

Like Lindsley, Kroeker and Oetting employed interval schedules to determine if patients could make the basic assessment that reinforcement was time and not response dependent. In a study of the performance of 15 males, 10 patients, five normals, on a FI 1 min schedule, Kroeker and Oetting found that "normal subjects were better able to develop a new behavioral repertoire appropriate to unique stimulus conditions than were mental patients (p. 727)." Long, Hammack, May, Campbell (1958), in a study with normal children 4-8 years old found that when subjects were started on a FI 1 min schedule they typically developed scalloping after six or seven reinforcements. In the Kroeker and Oetting study, however, no mental patient responded efficiently to the FI schedule. "In all cases the error may be described as a behavioral excess rather than a behavioral deficit (p. 727)."

The research to date, then, indicates that one characteristic of patients labeled as psychotic is the inability to assess environmental control based on intervals
of time. However, a closer look at the results of these studies may render this statement premature. Lindsley's data show that on a VI 1 min schedule the psychotic characteristically responds at an extremely slow rate and with many pauses.

Kroeker and Oetting's data concerning the performance of psychotics on a FI 1 min schedule show that no patients learned the schedules as the normals did and yet there was a characteristic pattern to their inappropriate behavior—they overresponded.

It is the purpose of this study to investigate the nature of these characteristic abnormalities. At face value it would appear, on the basis of the above mentioned studies, that psychotics while not responding normally on VI and FI schedules, might, in fact, respond differently on a FI 1 min and VI 1 min schedule. On the VI schedule they would be expected to respond at a low rate to environmental contingencies, taking frequent pauses greater than 10 sec. The time which they spent not responding should also be related to their ward behavior. The higher the response rate the less severe the psychosis. When then transferred to a FI schedule, the psychotic could then be expected to overrespond to environmental contingencies.

The reverse is true of going from an FI to a VI. The psychotic would change his pattern from overresponding
to environmental contingencies to underresponding. Regardless of the inappropriateness of his responding the psychotic would nevertheless be responding differently on the two different schedules.

This study will then investigate the characteristic responses of psychotic patients as compared to normals during the acquisition period of conditioning on VI 1 min and FI 1 min schedules to determine if a discrimination is made by the patients between the two schedules in the previously reported direction.
METHOD

Subjects

The subjects (Ss) were six male patients at the Kalamazoo State Hospital and four normals who are employed at the Kalamazoo State Hospital. All patients were traditionally diagnosed as schizophrenic. The subjects ages range from 29 years to 47 years with a mean age of 38. The length of hospitalization was from six years to 29 years with an average of 17 years. All patients were currently on the drug Mellarill.

Apparatus

The experiment was conducted in a 4' x 8' x 8' experimental chamber containing a chair, a Lindsley-type manipulandum, and a reinforcement tray 5" to the left of the manipulandum. About 300 gm force was required to pull the brass rod which activated the recording and reinforcement circuits. A Gerbrands universal feeder mounted on the opposite side of the manipulandum wall was used to deliver the reinforcements of nickels. All programming and recording circuitry were located in a nearby control room. An Esterline Angus Recorder was used to graphically register Ss responses and reinforcements delivered. Counters were
used to register the number of responses 10 sec before and 10 sec after reinforcement on the FI 1 min schedule. A printout counter recorded the number of responses per 1 min interval on the FI schedule and counters registered total number of responses, total number of reinforcements and time elapsed for both schedules.

A small red light mounted on the human chamber control panel in the control room indicated the condition of the manipulandum; if the S had the lever pulled out the light was on. Subject 3 characteristically held the knob out on the VI schedule. This was indicated by the light staying on. Since this aspect of his responding was considered significant the event recorder was additionally programmed to record the duration of the response.

Procedure

The Lucerno-Meyer Fergus Falls Behavior Rating Sheet was completed on 30 of the 44 patients on one hall with the exception of Item F, "Response to Electric or Insulin Therapy" which did not apply. Six of the 15 patients rated by one attendant were chosen as Ss on the basis of their scores. Three high scorers and three low scorers were chosen. The authors of the scale report a reliability coefficient of .92 and .94. In the present study no further check of reliability was
made. The scale deals with 10 observable ward behaviors; work, meals, response to other patients, response to aids and nurses, to doctors, social workers, psychologists, occupational therapists, dress, psychomotor activity, speech and toilet behavior. Each behavior can be rated from one to five, resulting in a total possible score of 10 for lowest level patients to 50 for highest level patients. Following are the LMBS scores of the patients used in this study:

\[
\begin{align*}
S1 & = 19.5 & S4 & = 31.5 \\
S2 & = 44.0 & S5 & = 28.0 \\
S3 & = 19.5 & S6 & = 22.5
\end{align*}
\]

Each subject was seated in the chair facing the manipulandum. The experimenter pulled the lever and a nickel fell into the reinforcement tray. The Ss were told they could keep all of the money they earned in the 40 minute session. One week was allowed to elapse between VI and FI sessions for each subject to minimize preconditioning effects.
RESULTS

VI 1 Minute

Table 1 represents the three response measures used in the analysis of VI data: (1) the rate of response, (2) the total number of IRT greater than 10 sec, (3) the sum of IRT greater than 10 sec.

Table 1

Operant conditioning response measures for patients and normals on a VI 1 min schedule during a 40 min session.

<table>
<thead>
<tr>
<th>Patients</th>
<th>Total Number Of Responses (40 Min)</th>
<th>Number of IRT Greater Than 10 Sec</th>
<th>Sum of IRT Greater Than 10 Sec (In Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>70</td>
<td>39</td>
<td>38</td>
</tr>
<tr>
<td>S2</td>
<td>160</td>
<td>104</td>
<td>30</td>
</tr>
<tr>
<td>S3</td>
<td>3009</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>S4</td>
<td>3156</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>S5</td>
<td>4520</td>
<td>3</td>
<td>1/2</td>
</tr>
<tr>
<td>S6</td>
<td>6535</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Normals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7</td>
<td>1353</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>S8</td>
<td>2177</td>
<td>27</td>
<td>8</td>
</tr>
</tbody>
</table>
The normals show a moderately high rate of response and took several short interresponse pauses. Subjects 1 and 2 responded at a low rate and took a high number of interresponse pauses lasting longer than 10 sec. However, S3, 4, 5, and 6 responded at an extremely high rate throughout the session taking few or no interresponse pauses for an average of .61 sec spent not responding.

There seems to be no relationship between the S's score on the LMBS and their rate of response. Subjects 1, 3, and 6 received low scores on the LMBS and S2, 4, and 5 received high scores.

FI 1 Minute

Table 2 represents the analysis of the subjects performance on the FI 1 min schedule in terms of the number of responses, number of reinforcements, variability, scallop index and efficiency index. The measure of variability was the standard deviation of the number of responses during 1 min intervals. The efficiency index was obtained by dividing the number of responses by the number of reinforcements on the FI schedule. The optimal number of responses on the FI schedule is 1. The scallop index is defined by the formula: \[ \frac{Nb - Na}{Nb} \times 100. \]
(Nb = number of responses 10 sec before reinforcement; 
Na = number of responses 10 sec after reinforcement).

This scallop index "assesses the S's awareness of rein­forcement contingencies (Kroeker and Oetting, 1969, p.
725)." The higher the index score the more efficient
the response pattern. The lower the index score the
less efficient the response pattern. In terms of total
responses the normals and low responding patients are not
clearly differentiated. Two patients have total number
of responses within the range of the normals and one of
these patients has a scallop index of 90, higher than
either normal. The other patients, S3, 4, 5, and 6
responded at a high rate compared to normals. Subject 2
who obtained the most adequate performance on the scallop
index of all Ss also scored the highest (4) on the LMBS.
Other than this there was no correspondence between the
LMBS and FI scores.

Comparison of Performance on
FI and VI

On the VI, S1 had the least adequate performance
with only 70 responses. This inefficiency is reflected
in his only receiving 19 reinforcers (as compared to 38
reinforcers earned by S7). Subject 1 clearly can be
categorized as a characteristic underresponder as
described by Lindsley.
Table 2

Operant conditioning response measures for patients and normals on an FI 1 min schedule during a 40 min session.

<table>
<thead>
<tr>
<th>Patients</th>
<th>Total Number of Responses</th>
<th>Number of Reinforcers</th>
<th>Variability</th>
<th>Scallop Index</th>
<th>Efficiency Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-10 Min</td>
<td>30-40 Min</td>
<td>0-10 Min</td>
<td>30-40 Min</td>
</tr>
<tr>
<td>S1</td>
<td>194</td>
<td>8</td>
<td>6</td>
<td>7.4</td>
<td>1.8</td>
</tr>
<tr>
<td>S2</td>
<td>117</td>
<td>9</td>
<td>7</td>
<td>1.8</td>
<td>.75</td>
</tr>
<tr>
<td>S3</td>
<td>553</td>
<td>8</td>
<td>10</td>
<td>3.8</td>
<td>5.1</td>
</tr>
<tr>
<td>S4</td>
<td>3247</td>
<td>9</td>
<td>10</td>
<td>29.0</td>
<td>4.8</td>
</tr>
<tr>
<td>S5</td>
<td>3616</td>
<td>9</td>
<td>9</td>
<td>16.5</td>
<td>14.5</td>
</tr>
<tr>
<td>S6</td>
<td>6277</td>
<td>9</td>
<td>10</td>
<td>8.8</td>
<td>36.0</td>
</tr>
<tr>
<td>Normals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S9</td>
<td>126</td>
<td>5</td>
<td>9</td>
<td>6.5</td>
<td>2.7</td>
</tr>
<tr>
<td>S10</td>
<td>280</td>
<td>8</td>
<td>9</td>
<td>4.9</td>
<td>2.1</td>
</tr>
</tbody>
</table>
However, when placed on a FI 1 min schedule, S1 more than doubled his rate of response. During the first 10 min of the FI schedule, S1 made 63 responses as compared to 18 responses in the first 10 min of the VI schedule, so the change of pattern developed rather immediately and was maintained throughout the session. In the last 10 min of the FI schedule, he made 29 responses as compared to 11 responses in the last 10 min of the VI schedule.

Subject 2, also a low responder on the VI, was extremely efficient on the FI. However, contrary to S1, S2's rate of response decreased on the FI schedule. During the first 10 min he responded at the same rate or pattern on both schedules: VI 50 FI 45, but during the last 10 min on the VI he became increasingly efficient and his rate decreased markedly: VI 57 FI 18. There was an overall difference of 25% between the number of responses in the two performances.

Subject 3 did not substantially change his pattern of responding on either the VI or FI. The data, however, do not reflect this failure to change because on the FI the S consistently held out the lever so that he was actually responding at a very high rate. During the last 10 min of the FI schedule the event recorder was programmed to show this and when compared to the event record of the VI schedule, it shows a similar rate of response.
Subject 3 had a very low scallop index (40) on the FI schedule and can be characterized as an overresponder on both schedules.

Subject 4 had a nearly identical response pattern on both schedules. He had a low scallop index of 6.5 on the FI but had a very high response rate as is true of his VI performance.

Subject 5's performance on both can be described as immediate high rate of response distinguished by short pauses after reinforcement. Subject 5 can be characterized as an overresponder on both schedules and as making no discrimination between the two schedules.

Subject 6 began responding at an extremely high rate on both schedules, making no discrimination between the two schedules.
DISCUSSION

The results of this study show that the normal Ss were indeed more capable of developing a new behavioral repertoire appropriate to unique stimulus conditions than were the mental patients. On the VI schedule patients typically either underresponded and failed to gain the optimal benefits from the reinforcement schedule or grossly overresponded, expending a tremendous amount of superfluous energy in gaining the reinforcers.

The data, however, do not support the aforementioned findings of Lindsley (1956, 1964) or Lindsley and Mednick (1958) that there is a characteristic underresponding among psychotics on a variable interval schedule. Nor were the findings of Kroeker and Oetting (1969) substantiated, that psychotics characteristically overrespond on FI schedules. Four patients responded at a high constant rate on both schedules and two patients responded at a low rate on both schedules suggesting that their behavior was not a function of the contingencies of the environment but a stereotyped pattern. The low responders, however, did modify their response rate when changed from the VI to FI schedule, but nevertheless remained low responders.

Two of the four high responding patients were rated
high on the LMBS and two were rated low. One low responder was rated high and the other was rated low. These results render the rating procedure virtually meaningless in this investigation.

This study, therefore, does not support the previous suggestions by Lindsley (1956, 1960), Mednick and Lindsley (1958), Kroeker and Oetting (1969) of the ability to characterize psychotic behavior on interval schedules and to derive from this a diagnostic device. This investigation suggests that instead of establishing a continuum of severe to mild mental illness on the basis of the sum of IRT greater than 10 sec on VI schedules, and overresponding on FI, that the emphasis be placed on the modifiability of an individual's behavior. A pattern of responding, whether consistently low or consistently high which does not alter regardless of the reinforcement contingencies employed, could be considered inappropriate. The ability to alter one's response pattern, regardless of the efficiency of that alteration, could be considered a more appropriate response to the environment.
BIBLIOGRAPHY


