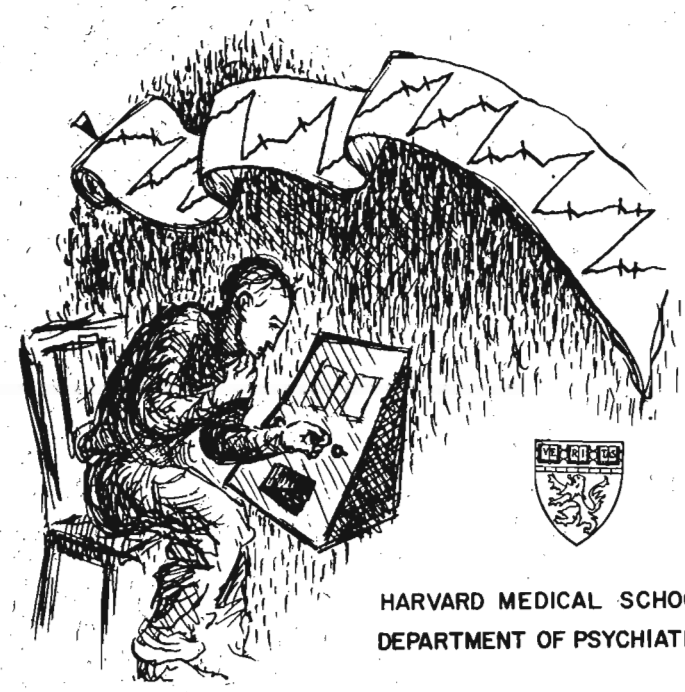
ANNUAL TECHNICAL REPORT 3

Report for the third year on

NEW TECHNIQUES OF ANALYSIS OF PSYCHOTIC BEHAVIOR
and
FINAL TECHNICAL REPORT FOR CONTRACT N5-ori-07662

Period Covered: 1 September 1955 - 15 November 1956



HARVARD MEDICAL SCHOOL
DEPARTMENT OF PSYCHIATRY

BEHAVIOR RESEARCH LABORATORY

METROPOLITAN STATE HOSPITAL, WALTHAM, MASS.

Research under Contract

with the

OFFICE OF NAVAL RESEARCH, U. S. NAVY

Contracts N5-ori-07662 and Nonr-1866(18)

Authority NR 174-220

HARVARD MEDICAL SCHOOL

Department of Psychiatry

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Metropolitan State Hospital, Waltham, Massachusetts

ANNUAL TECHNICAL REPORT 3

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NEW TECHNIQUES OF ANALYSIS OF PSYCHOTIC BEHAVIOR
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FINAL TECHNICAL REPORT FOR CONTRACT N5-ori-076262

Period Covered: 1 September 1955 - 15 November 1956

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Authority NR 174-220

Project Number:	Contracts N5-ori-07662 and Nonr-1866(18) sponsored by the Group Psychology Branch, Office of Naval Research, Authority NR 174-220.
Project Title:	New Techniques of Analysis of Psychotic Behavior.
Project Directors:	B. F. Skinner, Professor of Psychology, Harvard University. Harry C. Solomon, Professor of Psychiatry, Harvard Medical School.
Report Prepared By:	Ogden R. Lindsley, Research Associate, Harvard Medical School.
Period Covered:	1 September 1955 to 15 November 1956.
Previous Reports:	Status Report I, 30 November 1953 Status Report II, 31 May 1954 (Annual Technical Report 1) Status Report III, 31 December 1954 Status Report IV, 31 August 1955 (Annual Technical Report 2) Status Report 5, 15 May 1956 Status Report 6, 15 August 1956

Change of Report Terminology:

Since our report titles are not in accord with the titles suggested by the Office of Naval Research, we are altering our terms. Status Reports II and IV summarized the results of the first and second years' work and should be titled "Annual Technical Report" 1 and 2, respectively. Hereafter our Status Reports will be dated 15 February, 15 May, and 15 August and will be sent only to the Office of Naval Research (5 copies). Our Annual Technical Reports will be dated 15 November and will be mailed to our complete distribution list. Our Interim Technical Reports (reprints) will appear when completed and will be mailed to the complete distribution list.

Availability of Reports:

Our supply of Status Reports I, II, and III is exhausted. Rather than mimeograph additional copies of our old reports we have made them available on Microcards from the Microcard Foundation, Madison 5, Wisconsin.

Publications:

1. Lindsley, O. R. & Skinner, B. F. A method for the experimental analysis of the behavior of psychotic patients. Amer. Psychologist, 1954, 9, 419-420. (Abstract.)

2. Skinner, B. F., Solomon, H. C. & Lindsley, O. R. A new method for the experimental analysis of the behavior of psychotic patients. J.Nerv.Ment.Dis., 1954, 120, 403-406. (Interim Tech. Rept. 1.)

3. Skinner, B. F. Critique of Psychoanalytic Concepts and Theories. Scientific Monthly, 1954, 79, 300-305.

4. Azrin, N. H. & Lindsley, O. R. The reinforcement of cooperation between children. J.Abnorm.Soc.Psychol., 1956, 52, 100-102. (Interim Technical Rept. 2.)

5. Lindsley, O. R. Operant conditioning methods applied to research in chronic schizophrenia. Psychiat.Res.Rep., 1956, 5, 118-139. (Interim Technical Rept. 3.)

6. Raines, G. N., Chairman. Discussion of paper presented by Ogden R. Lindsley. Psychiat.Res.Rep., 1956, 5, 140-153. (Interim Technical Rept. 4.)

7. Skinner, B. F. What is Psychotic Behavior? In Theory and Treatment of the Psychoses: Some Newer Aspects. St. Louis, Mo.: Washington University Studies, 1956, 77-99. (Interim Technical Rept. 5.)

Additional Support:

In addition to the contract with the Office of Naval Research, the laboratory was supported by research grant MH-977 from the National Institute of Mental Health, of the National Institutes of Health, Public Health Service, since 1 December 1954. Work done under the Public Health Grant is not included in this report, but is described in Progress Report I of PHS grant MH-977, 1 June 1956.

LABORATORY PERSONNEL

During the period covered by this report the following personnel have been members of the laboratory staff:

B. F. Skinner, Ph.D., Director. Professor of Psychology, Harvard University.

Harry C. Solomon, M.D., Director. Professor of Psychiatry, Harvard Medical School.

Ogden R. Lindsley, Sc.M., Chief Investigator, Research Associate, Harvard Medical School.

*Martha Mednick, Ph.D., Clinical Psychologist.

*Nathan Azrin, Ph.D., Graduate Research Assistant.

*Richard Wylie, A.B., Graduate Research Assistant, (part time).

Richard Flavin, Undergraduate Research Assistant, (part time).

Lawrence Gilbert, Undergraduate Research Assistant, (part time).

Robert C. Dalrymple, Laboratory Assistant.

William J. Nichols, Senior Technician.

Mollie D. Boring, M.A., Secretary, (part time).

Rita J. Wanner, Secretary, (part time).

*Mary V. Hall, Secretary.

John Bixby, Laboratory Custodian, (part time).

*The individuals with asterisks before their names are no longer on the laboratory staff. Dr. Mednick is now a USPHS Post Graduate Fellow affiliated with the project.

The list of personnel contained in our last report, (Progress Report I, Grant MH-977, National Institute of Mental Health, Public Health Service) was in error and the present list of personnel is to be considered as the correct list for the period covered by both reports.

LABORATORY PERSONNEL (Cont'd)

The following personnel have been of assistance to the project:

Jack Ewalt, M.D., Commissioner of the Massachusetts Department of Mental Health, made available the facilities of the State Hospital system.

William F. McLaughlin, M.D., Superintendent of the Metropolitan State Hospital, provided the research space and hospital facilities.

Myer Asekoff, M.D., Director of Clinical Psychiatry at the Metropolitan State Hospital, assisted in the selection and care of the patients.

Sol Sherman, M.D., Senior Physician at the Metropolitan State Hospital, assisted in the care and medication of the patients who received pharmacological treatments.

Karl Theo Dussik, M.D., Research Fellow, Boston Dispensary, and Assistant Physician at the Metropolitan State Hospital, assisted in the selection, care and medication of the insulin patients.

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GENERAL SUMMARY

Method[1] The purpose of this project is to analyze the behavior of chronic psychotic patients, using the methods of operant conditioning that have been proved effective in the study of the behavior of lower organisms. In brief, a volunteer patient is placed alone in a small room containing a chair and a modified vending machine. When the patient pulls the vending machine levers, pieces of candy or other suitable reinforcements are delivered. The number and distribution of responses are automatically recorded over a specified length of time. In this manner the quantity and regularity of operant or adjustive behavior[2] of each patient can be ascertained under controlled conditions.

The method is not limited to such simple behavior, for when the experimental conditions are varied a wide range of behavior can be objectively studied. Complex response development, discriminations, concept formation, motivational conflict, fear, anxiety, and verbal behavior have been successfully studied with this method. With two individuals placed in "yoked" rooms, many forms of elementary social behavior (for example, competition, cooperation, imitation, negativism, altruism, sadism, etc.) may be studied. The differences in the rates of such behaviors between different individuals (psychotic or non-psychotic) as well as the effects of different agents (environmental, pharmacological, neurological) upon these rates can readily be studied.

Previous Results[3] Suitable apparatuses and procedures for the study of the operant behavior of chronic psychotic patients have been developed and standardized. Since the apparatuses are similar to those currently used with lower organisms by many experimental and physiological psychologists, our results can be directly compared with theirs. This brings theoretical and experimental continuity to the fields of clinical, physiological and experimental psychology.

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1. The method is described in detail in Status Report II and in Interim Technical Report 3; Lindsley, O. R. Operant conditioning methods applied to research in chronic schizophrenia. Psychiat. Res. Rep., 1956, 5, 118-139.

2. An operant response is a segment of behavior that manipulates a part of the environment. If it is followed by a reinforcement its rate increases. The clinical term "adjustive behavior" is often used to describe reinforced operant behavior. Many patients were hospitalized because they did not have enough adjustive behavior to function in society.

3. These results are described in detail in our previous reports and publications (see pages 2 and 3).

Approximately 50% of the adult patients responded at significantly lower and more erratic rates than unhospitalized adults, psychotic children, or lower organisms. When the adult patients were not responding they engaged in their particular psychotic behavior (pacing, sitting "depressed," gesticulating, talking violently, etc., depending upon their symptoms). This psychotic behavior interferes with and displaces the operant behavior. The topography of the psychotic behavior correlates with the psychiatric diagnosis, but the diagnosis gives no indication of the degree to which the psychotic mannerisms interfere with the operant behavior. Each patient has a characteristic pattern of psychotic "distraction," some showing frequent distractions of short duration, others showing infrequent periods of very long duration. Minute-to-minute, hour-to-hour, day-to-day, and month-to-month rhythms in the degree of this psychotic distraction have been recorded and are characteristic of different patients. We have succeeded in altering the frequency, duration, and patterning of these distractions by manipulating the nature or schedule of reinforcement with some patients. Individual differences are the rule and appear to be our subject matter. We cannot employ large-sample screening methods (wherein a large number of subjects are observed for a short period of time each) because of these rhythms and individual differences. Our research is in the main intensive with many hours of observation accumulated on a relatively small group of patients (N = 50).

Present Status of Research We have completed the methodological phase of our research and are now ready to spend our full research time on the analysis of psychosis. In the past three years we have investigated many aspects of psychotic behavior, but much of our time has been spent designing and constructing equipment, looking for suitable reinforcers, and testing the reliability and stability of our data. We now have suitable equipment for the free operant conditioning of psychotics. It can be used to study any individual from out-patient to the most severely disturbed violent patient. It has been tested in operation, is standardized and is commercially available. We can provide other researchers with equipment, standardized data, and counsel concerning the initial problems of patient handling, research design and hospital integration and cooperation. To this end we can draw upon a file of over 10,000 patient-hours of data with a median of 94 experimental sessions on 51 adult and 35 child psychotic patients.

We are embarking on a comprehensive analysis of the behavior of chronic psychotics. It promises to be a long-term investigation with all the advantages and disadvantages of "pure research" in any field. We plan to spend approximately 25% of our laboratory time in the application of promising research "leads." Our investigations of the effects of the standard therapies and the new tranquilizing drugs fall in this category.

The data generated are stable over long periods of time (years), and reveal striking individual differences between patients and unhospitalized individuals. We have located a few behavioral anomalies in our patients and now plan to search for other behavioral differences between our patients. Having located such anomalies, we plan to screen a sample of 25 patients to obtain a rough estimate of the frequency of occurrence of each anomaly in a hospital population. If we use the same sample of patients for each screening, inter-correlations of anomalies are possible and "behavioral disease syndromes" might be collected. It is becoming apparent that one of our most important assets here in Waltham is the large body of data we have accumulated on each of our fifty patients.

1.0 WORK ACCOMPLISHED SINCE 1 SEPTEMBER 1955

1.1 Observations on New Patients:

We have studied the behavior of 15 new patients since our last annual report. This increases our total sample to 51 adult psychotic patients (three of these were female) and 35 child psychotic patients (two of these were female). The distribution of staff diagnoses for the adult patients we have studied to date follows:

Psychoneurotic	1
Psychotic	2
Dementia Praecox, Undifferentiated type	4
" " Other types	7
" " Paranoid type	12
" " Catatonic type	13
" " Hebephrenic type	3
Mentally Defective with Psychosis	5
Manic-Depressive	1
Alcoholic Psychosis	2
CNS Syphilis	1
Total	51

Five of these patients were also described as having some organic involvement. These psychiatric diagnoses have so far not correlated with the different measures of the patients' operant behavior in the experiments, and we include them only as descriptions of our population until we can obtain more detailed and more recent psychiatric evaluations.

As we have previously stated, the psychiatric diagnoses do rather loosely describe the pattern of each patient's psychotic symptoms. They describe what the patient is apt to be doing in the experimental room when he is not responding. They do not give information about the nature of the patient's behavior anomalies or deficits. They do not say that this patient does not work because he is not motivated, nor that that patient is motivated, but cannot learn the task. The psychiatric diagnoses seem to say: when this patient is not working he will be pacing, and that patient will be mumbling, and this one laughing, etc.

The patients' ages ranged from 18 to 63 years, with a median age of 39 years. Total hospitalization for mental ilness ranged from 1 to 47 years with a median of 15 years. Six percent of our patients were hospitalized less than 1 year and 27 percent were hospitalized 5 years or less. I.Q.'s were available on only 23 patients (approximately 45 percent were untestable).[1] The most recent I.Q.'s ranged from 9 to 116, with a median of 82. Such depressed I.Q.'s are usually found in chronic psychotics.

On the L-M Fergus Falls scale[2] for rating the ward behavior of chronic psychotics, our patients received ratings from 1.3 to 5.0 with a median of 2.4. (1.0 is severely disturbed and 5.0 represents normal adjustment to the ward.) These values compare favorably with the range of 1.3 to 4.7 and the median of 2.5 obtained by Lucero and Meyer in their original standardization of the scale on over 50 patients in the Fergus Falls State Hospital, Minnesota.

Further evidence of the representativeness of our sample is given by the following distribution of the percentages of patients in the different type wards for the total male population of Metropolitan State Hospital compared with our sample of that population.

Population	N	Type of Ward				
		Admission (Reception)	Parole (Open)	Closed (Locked)	Disturbed (Violent)	Regressed (Untidy)
Total Hospital (Male)	622	7%	50%	27%	6%	10%
Exptl. Group	51	8%	36%	40%	12%	4%

Therefore our sample is representative of the patients in large state mental hospitals.

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1. The results of our clinical testing program, which was conducted by Dr. Martha T. Mednick, are reported in detail in: Lindsley, O.R., Progress Report I, Research Grant MH-977, National Institute of Mental Health, National Institutes of Health, Public Health Service and Harvard Medical School, June 1956.

2. Lucero, R. J., and Meyer, B. F. A behavior rating scale suitable for use in mental hospitals. J.Clin.Psychol., 1951, 7, 250-254.

During the past three years, five of our patients have been discharged, one escaped and has not been found, and one died. Therefore, seven patients (14%) are no longer available for study. However, this figure includes three discharged acute patients with whom we were studying the effects of insulin therapy and who cannot properly be called chronic patients. At the current rates we can expect to lose about 3% of our chronic patients per year, due to discharge, escape and death.

Tripling the size of our patient population since our first annual report (Status Report II, 31 May 1954) has not changed the nature of our initial conclusions. By increasing the size of our sample, we have, of course, increased the probability that our conclusions will apply to psychotics in general, and we have been able to make more conclusions about the behavior of psychotics as we complicate our experiments and study more complex behaviors.

1.2 Quantification of "Psychotic" Properties of Records:

In our first status report we said that the most disturbed patients responded irregularly, with pauses separating periods of responding. During these pauses a patient would engage in his particular psychotic symptoms. Since then, we have accumulated a convincing body of data showing that this irregular response rate indicates severe psychosis if the patient is not physically ill or handicapped, unduly fatigued, or suffering from recent punishment or extinction. In other words, many factors can cause an irregular rate of response, but if the conditions under which normal individuals respond at irregular rates are ruled out, then an irregular response rate does indicate the presence of severe psychosis. The following evidence has been accumulated:

1) Patients assigned to the most regressed wards pause longer than those on open wards.

2) Patients rated as the most disturbed by the L-M Fergus Falls behavior rating scale pause longer than those rated high in hospital adjustment.

3) Normal attendants and psychotic children do not make these long pauses.

4) Patients with cycles of psychotic disturbance have long pauses when they are most disturbed and shorter pauses when they are in periods of better adjustment.

5) Most patients show roughly the same amount of pausing regardless of the reinforcement.

6) The frequency and/or duration of pausing is not related to psychiatric diagnosis or duration of hospitalization. It measures, therefore, the degree of debilitation caused by the psychosis, but does not describe the topographical nature of the symptoms.

It has been possible to exert some degree of experimental control over these "psychotic" pauses. In a few cases, they have been reduced in duration and frequency through months of daily conditioning on a one-minute variable-interval schedule of reinforcement in which the first response after a long pause is usually reinforced. The pauses have been increased in duration and frequency by experimental extinction. In other cases, we have "forced" the psychotic pauses (and the symptoms filling them) into temporal position following each reinforcement on a fixed-ratio schedule (i.e., every twentieth response is reinforced). On the fixed-ratio schedules, the pauses tend to be lengthened as well as positioned after reinforcement.

Since the pauses provide a measure of the severity of a psychosis by calibrating the degree to which it interferes with a standard task, and since the pauses can be changed in frequency and duration by experimental manipulation, a careful quantification of these pauses was demanded for further experimentation.

An analysis of the cumulative records and a few inter-response time distributions taken from both patients and normals disclosed that few normal records showed any pauses greater than ten seconds. This is about the length of time it takes the normal individual to look at his watch, light a cigarette, adjust his chair, or engage in any one of a host of "normal distractions." Distractions which consumed longer periods of time tended to be bizarre and in most cases were made only by disturbed patients.

On 10 December 1955 we started automatically measuring the amount of time consumed by pauses over ten seconds in length by the use of a clock (elapsed time indicator) which started ten seconds after each response and ran until the next response. The clock also ran during the initial delay in responding from the start of the experimental session (latency). This measure, described as "the sum of the inter-response times greater than ten seconds" (Σ IRT$>$10"), was automatically computed by the clock for each experimental session with an accuracy to tenths of a minute. Since pauses of ten seconds duration or less (normal pausing) are not timed, the clock provides a measure of the amount of time consumed by abnormal pauses in each experimental session.

On 25 January 1956 we started recording the number of these pauses greater than ten seconds because the patients who made one

long pause of, say, 30 minutes were not being separated from the patients who made, say, 10 equally spaced 3-minute pauses during each 60-minute session by the Σ IRT>10". A counter was placed in the circuit which recorded "the number of inter-response times greater than ten seconds" (#IRT>10"). This measure must be used with caution for it can be ambiguous, since patients responding at high, even rates might have only a few inter-response times greater than ten seconds and patients responding at very low rates might have only one or two very long inter-response times over ten seconds. However, with this ambiguity kept in mind the measure has proven to be a sensitive indicator of properties of the rate which are not measured by the Σ IRT>10", the M IRT>10", or the total number of responses per hour.

Both measures can be reclaimed from earlier records that were collected before the recording circuits had been devised by reading the cumulative response curves with a grid. This is a time-consuming procedure, and economically unfeasible for large-scale research, but it illustrates one advantage of continuous experimental records which can be later analyzed using a system which was undiscovered at the time the behavior was recorded.

"The mean inter-response time greater than ten seconds" (M IRT>10") can be computed from these two measures by dividing the ΣIRT>10" by the #IRT>10". The mean provides a single measure combining the properties of both the sum and the number, and for this reason might be more economical than using both measures. However, we have continued to use both measures since we have found them to vary independently of each other in certain experimental situations (see below). Also, the labor of computing the mean is saved by using the automatically derived measures.

Table 1 shows the advantage of the Σ IRT>10" over the other measures of the rate of response in differentiating most disturbed patients from the less disturbed patients and from the normal individuals. The table also shows the non-monotonic nature of the #IRT>10" as related to the responses per hour and the resultant low P values caused by the ambiguity of this measure.

The untestable patients had significantly lower ratings on the Tulane Behavior Scale[1] of clinical testability (P>.01) and the Lucero-Meyer Scale[2] of ward behavior (P>.01). They also were assigned to the more regressed wards of the hospital (P>.06). These

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1. King, H.E. Psychomotor aspects of Mental Disease, Cambridge, Mass., Harvard University Press, 1954.

2. Lucero, R.J., & Meyer, B.F. A behavior rating scale suitable for use in mental hospitals. J.clin.Psychol., 1951, 7, 250-254.

Table 1

A summary of four rate of response measures from normal subjects compared with the same measures from a group of patients that could be tested by standard psychological tests and a group of untestable patients (45% of the patient population). The rate of response measures are medians for each group of the medians for the first 10 hours of one-minute variable-interval reinforcement with penny candies for each patient and five-cent pieces for each normal subject. The median number of responses per hour (Resp./Hr.), the median number of inter-response times greater than ten seconds (#IRT >10"), the median mean inter-response time greater than ten seconds (M IRT>10"), and the median sum of the inter-response times greater than ten seconds are presented. The numbers inside the parentheses are P values for two-tailed Median Tests done between the entries immediately above and below the P value concerned. Where three dashes are entered, the test was not significant. The table shows that the ΣIRT>10" is most sensitive to the presence of severe psychosis.

Subjects	N	Resps/Hr	#IRT>10"	M IRT>10"	ΣIRT>10"
Normal Attendants	6	9,566	2	.1'	.0'
		(---)	(---)	(---)	(.007)
Testable Patients (55%)	12	1,421	44	.8'	41'
		(.040)	(.070)	(.006)	(.006)
Untestable Patients (45%)	10	21	9	2.7'	58'

relationships add validity to the rate of response measures in showing that the patients with the lowest rates of response and longest inter-response times scored the lowest on three independent measures of severity of psychosis.[3]

Figure 1 shows the total number of responses per hour, #IRT >10", and Σ IRT >10", for one normal subject responding on a one-minute variable-interval schedule for five-cent pieces as reinforcers plotted against experimental sessions (one hour per day). Note that the rate of response sharply dropped at about the 25th experimental session. This sharp drop in rate to a lower value more in accord with the variable-interval schedule is similar to the abrupt changes in behavior which used to be called "insightful." Such changes may be more prevalent in the behavior of humans than with lower organisms. Note that there was a significant increase in the #IRT >10" at the time of the rate change only. The #IRT >10" here acted as the derivative of the rate of response and represents the kind of searching activity (exploring different sized inter-response times) the subject went through in adjusting his rate of response to a lower value. Note that since the Σ IRT >10" did not markedly change at this time, the independence of the #IRT >10" from the Σ IRT >10" is empirically demonstrated.

Another situation demonstrating this independence, in which the Σ IRT >10" is markedly changed with no apparent change in the #IRT >10" is shown in Figure 2.

Here the #IRT >10" and the Σ IRT >10" are plotted against the hour-long experimental sessions for one patient responding for 260 hours on a one-minute variable-interval schedule for candy reinforcement followed by 90 hours of no reinforcement (experimental extinction). Ten-day medians are plotted to condense the graph. During the first 20 hours of extinction there was a sharp drop in the rate of response, showing that the gradual increase in rate of response over 260 experimental sessions (over a year) was directly related to the reinforcing stimuli (candy) rather than to the attention paid the patient by removing him from the ward environment each day. Figure 2 shows that this sharp drop in rate of response during the first 20 extinction sessions was due to an increase in the duration of inter-response times greater than ten seconds (Σ IRT >10") rather than an increase in the frequency of these long inter-response

3. These results are described in detail in Progress Report I, Research Grant MH-977, National Institute of Mental Health, Public Health Service, Behavior Research Laboratory, Harvard Medical School, June 1956.

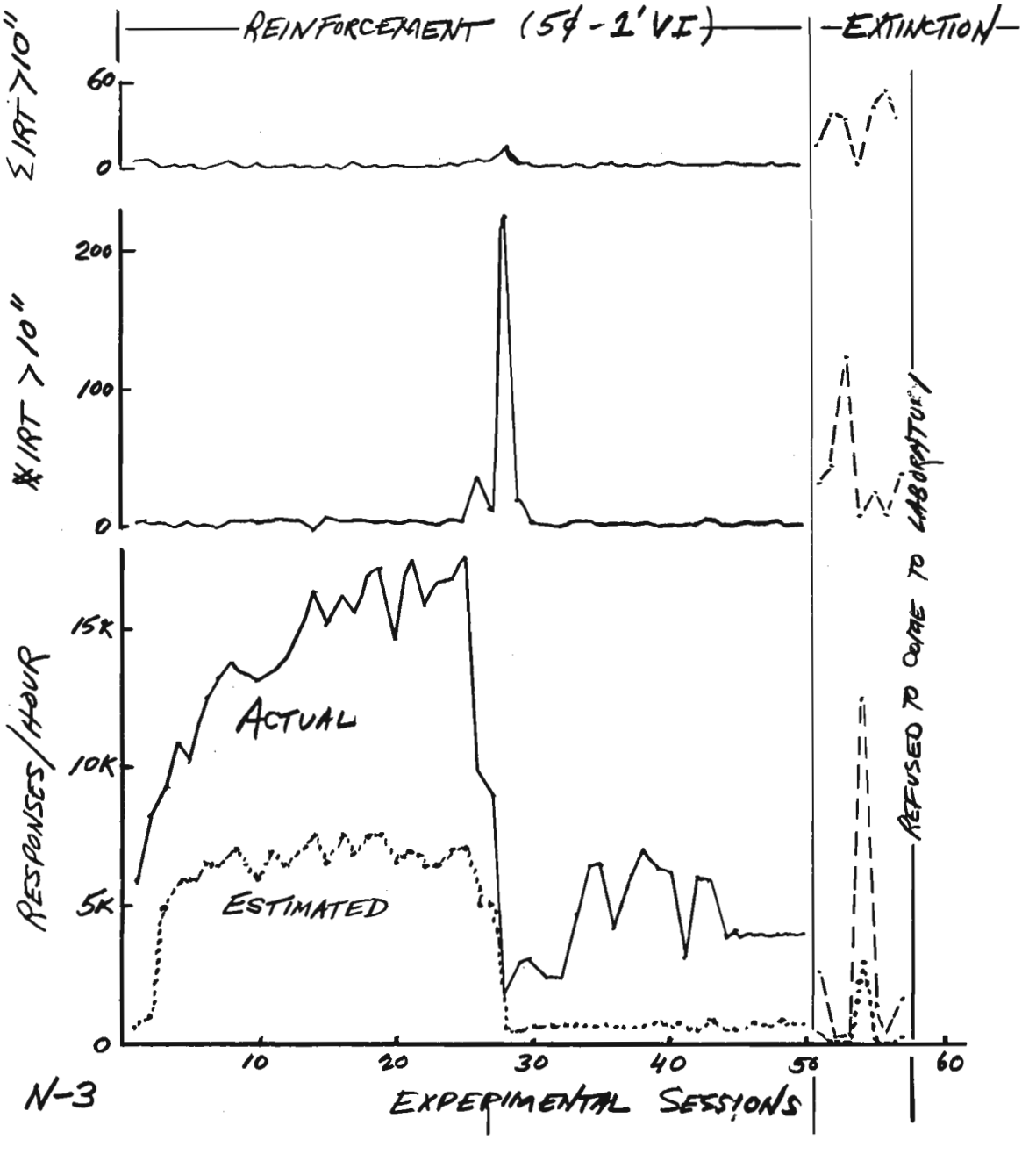
REINFORCEMENT (5' - 1' VI)
EXTINCTION
Σ IRT > 10"
60
0
IRT > 10"
200
100
0
RESPONSES/HOUR
15K
10K
5K
0
ACTUAL
ESTIMATED
REFUSED TO COME TO LABORATORY
10
20
30
40
50
60
N-3
EXPERIMENTAL SESSIONS

FIGURE 1

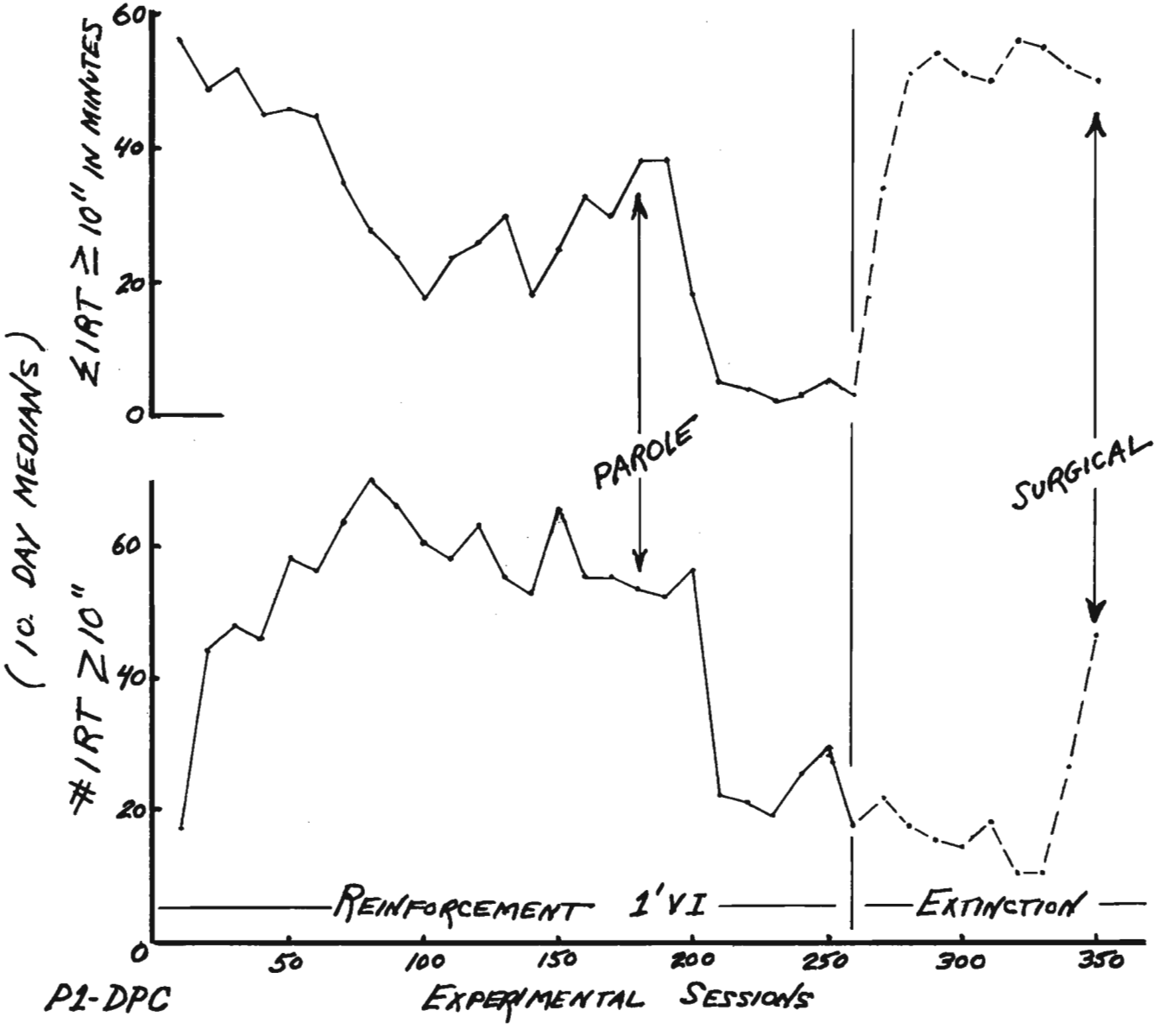
(10 DAY MEDIANS)
Σ IRT ≥ 10" IN MINUTES
IRT ≥ 10"
60
40
20
0
PAROLE
SURGICAL
REINFORCEMENT 1'VI
EXTINCTION
50
100
150
200
250
300
350
P1-DPC
EXPERIMENTAL SESSIONS

FIGURE 2

times (#IRT>10"). Therefore extinction increased the duration of the long inter-response times rather than their frequency.

In summary, the superiority of the Σ IRT>10" over the Responses/Hr., the #IRT>10", and the M IRT>10" as a measure of the degree of "psychotic distraction" within a record of operant behavior was demonstrated. The validity of the ΣIRT>10" as a measure of the severity of the psychosis was determined using three independent clinical measures. Also the empirical independence of the Σ IRT>10" from the #IRT>10" as well as the sensitivity of both measures to certain experimental changes was shown. For these reasons we will continue to record both the Σ IRT>10" and the #IRT>10" in addition to the number of responses per hour.

1.3 Quantification of "Fixed-Ratio Pauses":

Two schedules of intermittent reinforcement that we have used extensively are the "variable-interval" schedule and the "fixed-ratio" schedule. On the one-minute variable-interval schedule the magazine circuit is primed after periods of time varying from 10 seconds to 2 minutes from the last reinforcement (on the average, once every minute). One priming is sufficient to deliver a reinforcement when a response is made at any time after the priming. Only one reinforcement is delivered, regardless of the number of primings, so that extra primings are, in a sense, wasted. In order to obtain all potential reinforcements, the patients must respond at a rate high enough to ensure a response between the closest primings (an even rate of one response at least every 10 seconds). This schedule produces a low, even rate of response from most normal subjects. On the fixed-ratio schedule, reinforcements are delivered after a fixed number of responses have been made since the last reinforcement. On a fixed-ratio twenty schedule, every twentieth response is reinforced.

The fixed-ratio schedule has two different effects when compared to the variable-interval schedule. 1) The rate of response is increased over the variable-interval rate (usually both the number of responses per hour as well as the "local rate" immediately before reinforcement are increased). 2) Pauses in responding tend to occur immediately after each reinforcement. We have previously found[4] that approximately 1/3 of the adult patients showed both of

4. Status Report IV, ONR Contract N5-ori-07662, Behavior Research Laboratory, Harvard Medical School, August 1955.

these ratio effects, 1/3 showed pauses after reinforcement but no rate increase, and 1/3 showed neither effect. This showed that these two fixed-ratio effects can occur independently of each other, and therefore are not indicants of the same process. Pauses after reinforcement can occur without an increase in the number of responses per hour or the "local rate of response" immediately after reinforcement. To our knowledge, this separation of these two effects has never been observed with normal organisms. Thus one important contribution of the study of abnormal subjects might be to separate processes that always occur together in normal subjects and have, therefore, been considered as a unified process. In this way, the use of psychosis as an analytical tool might shed considerable light on some of the problems and theories of "normal psychology." All normal adults and psychotic children showed both fixed-ratio effects. These two fixed-ratio effects should be quantified, since they reveal individual differences in the behavioral capacity of psychotic patients and should, therefore, be valuable in future research.

The increase in rate of response has been quantified by recording the number of responses per hour for each experimental session. The increase in the "local rate of response" can be quantified by subtracting the sum of the long inter-response times (ΣIRT>10") from 60 minutes (the duration of the experimental session). The result is termed the "time spent responding" and can be divided into the number of responses in the entire session in order to determine the local rate, or "the rate when responding."

The quantification of the fixed-ratio pauses demanded a separate recording circuit in the apparatus. A separate counter and timer were made to record the number and sum of the durations of all inter-response times greater than ten seconds that occurred immediately after reinforcement (#IRT>10" after S^R and ΣIRT>10" after S^R). These two values were then converted into percentages of the total #IRT>10" and ΣIRT>10" for each experimental session. If all the pauses greater than ten seconds occurred immediately after reinforcements only, then the %#IRT>10" after S^R and the %ΣIRT>10" after S^R would both be equal to 100.

The values of the %ΣIRT>10" after S^R and the %#IRT>10" after S^R are very stable and appear to be approximately equal under most experimental conditions. On the variable-interval schedule of reinforcement 30 to 60% of the long pauses occur immediately after reinforcement. This is not attributable to the acquisition of the reinforcer, because 5 seconds (the magazine cycle) after each reinforcement is not counted as experimental time - the timers and recorder do not operate during this time. This five-second magazine cycle is long enough for reaching into the magazine and removing the reinforcer. The tendency for the very long pauses to occur immediately after reinforcement would seem to be related to one or more of the following: 1) the motivation (deprivation) is at its

lowest; 2) the probability of reinforcement is very low at that time; or 3) the presentation of the reinforcer acts as a catalyst or distractor which precipitates a chain of psychotic behavior symptoms that take a relatively long period of time to complete. The possible catalytic effect of the reinforcer could be checked by seeing whether removing the knob or presenting other strong stimuli might precipitate a chain of psychotic symptoms. We plan to investigate this possibility in the near future.

Consider Figure 3. Here the effects of two fixed-ratio schedules (FR20 and FR5) are compared with one-minute variable-interval performance (1'VI) for one chronic psychotic patient (P22). Ten-day medians are plotted in order to condense the graph. The reinforcer in all plotted sessions was candy (other reinforcers were used in sessions 201 through 240 and are not plotted). The one-minute variable-interval schedule produced a rate of response less than 100 responses per hour and a %ΣIRT>10" after S^R and %#IRT>10" after S^R ranging from approximately 30 to 60% (sessions 150 through 264). In all cases the %#IRT>10" after S^R was lower than the %ΣIRT>10" after S^R, showing that the long pauses after reinforcement tended to be longer than the long pauses that occurred at other times during the session. This tendency also exists in the behavior of the four other patients we have so far analyzed on the one-minute variable-interval schedule with respect to these measures.

When the schedule was changed to FR20 (every twentieth response reinforced), there was no change in the number of responses per hour, the #IRT>10" and the ΣIRT>10". However, the %ΣIRT>10" after S^R and the %#IRT>10" after S^R sharply dropped when the schedule was changed to FR20 (sessions 266 through 275). This shifting of the long pauses that occurred immediately after reinforcement on the variable-interval schedule to other places in the experimental session seems to be an immediate effect of the schedule change and has been reproduced with two other patients to date. The important point here is that the independence of the %ΣIRT>10" after S^R and the %#IRT>10" after S^R from the Responses/Hr., the ΣIRT>10" and the #IRT>10" was empirically demonstrated.

This independence was again demonstrated in sessions 276 through 300, when the %ΣIRT>10" after S^R and the %#IRT>10" after S^R gradually rose from approximately 40% to 80% with no corresponding change in the Responses/Hr., the ΣIRT>10", and the #IRT>10" when the schedule was changed to fixed-ratio 5. This is the second fixed-ratio effect that we set out to quantify. Note that the effect is very gradual, taking almost 50 experimental sessions of one hour each to be complete. Although we have no data on this effect from normal adults, psychotic children and lower organisms show this effect in approximately one-fifth of the experimental time it took for this adult patient. Note also that the %ΣIRT>10" after S^R shifts from a higher percentage value than the %#IRT>10"

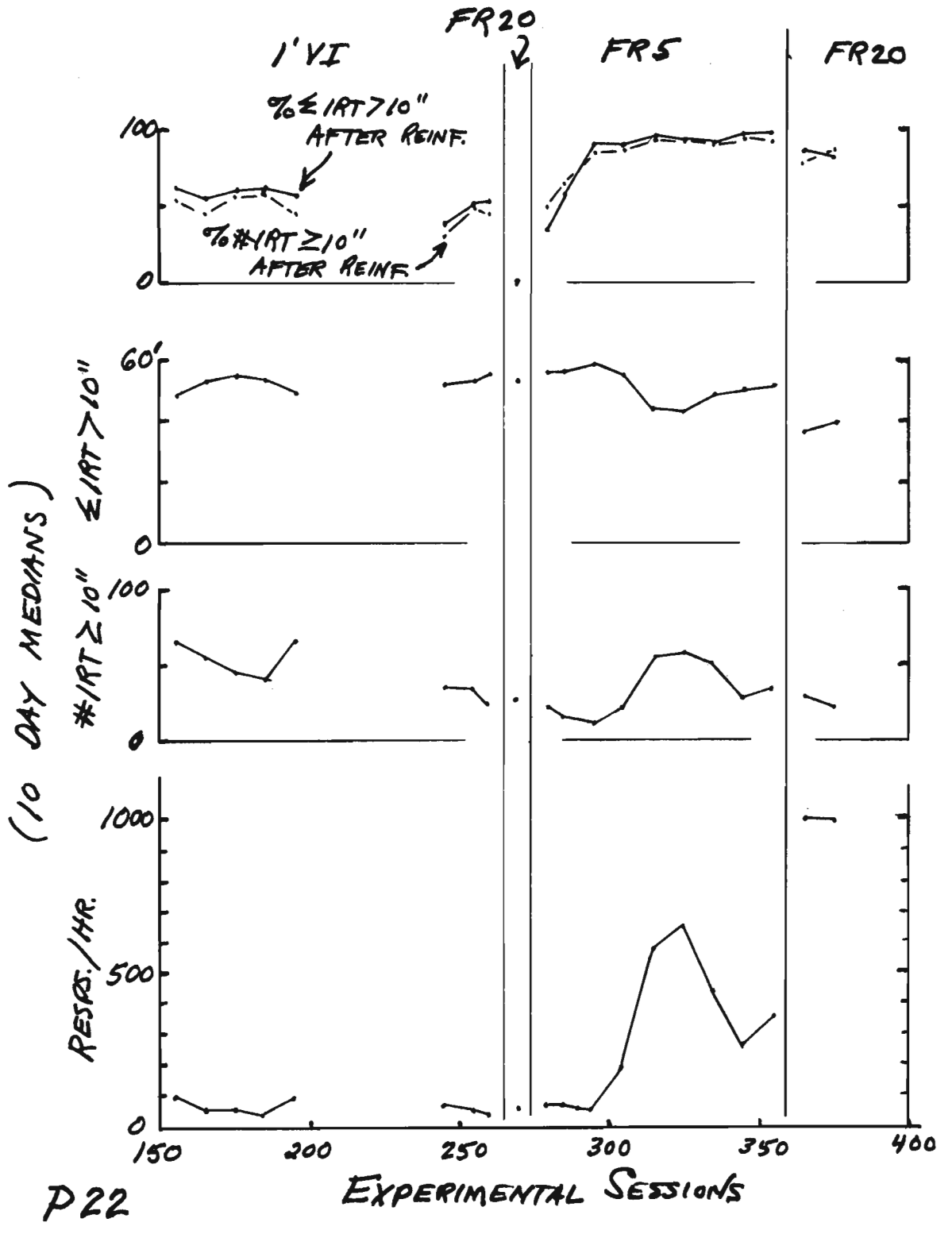
EFFECTS OF FIXED-RATIO SCHEDULES
FR20
1'VI
FR5
FR20
%ΣIRT≥10" AFTER REINF.
%#IRT≥10" AFTER REINF.
100
0
60'
0
100
0
1000
500
0
150
200
250
300
350
400
(10 DAY MEDIANS)
ΣIRT≥10"
#IRT≥10"
RESPS./HR.
P22
EXPERIMENTAL SESSIONS

FIGURE 3

after S^R to lower values during the first twenty sessions on fixed-ratio 20. To date we have no explanation for this shift. Another important point is that the tendency to pause after reinforcement (the 2nd fixed-ratio effect) was almost complete before the increase in the rate of response (the 1st fixed-ratio effect) began to occur. In lower organisms and psychotic children these two effects tend to occur together. Perhaps the extremely deteriorated adult psychotic is capable of only one adjustment at a time. Investigation of the behavior of more patients will permit us to test this generalization.

In sessions 301 through 360 there was a gradual increase in the Responses/Hr., and the #IRT>10", together with a gradual decrease in the $\leq$IRT>10". During this time there was no reduction in the %$\leq$IRT>10" after S^R and the %#IRT>10" after S^R. From sessions 361 through 381 the schedule was changed back to fixed-ratio 20. Note that this time, after 85 previous sessions on fixed-ratio 5, there was no extreme drop in the %$\leq$IRT>10" after S^R and the %#IRT>10" after S^R. Rather, the percent of long pauses occurring immediately after reinforcement remained at a high value and the number of responses per hour sharply increased (both effects appropriate to the fixed-ratio schedule). It appears that the patient adjusted to the fixed-ratio 20 schedule after previous training on fixed-ratio 5 much more rapidly and appropriately than he did without this pre-training on a lower fixed-ratio value.

This difficulty in adjusting to high fixed-ratio values without pre-training on low values has been termed "straining the ratio" by Ferster and Skinner[5] and is observed with lower organisms at much higher fixed-ratio values (usually in the hundreds). Although we lack conclusive evidence, here again the chronic psychotic might be lacking in the modifiability of his behavior, needing more experimental time and less severe schedule changes in order effectively to adjust his behavior to the new experimental conditions.

In summary, it is clear that the quantification of these two fixed-ratio effects has revealed interesting individual differences in the behavior of the chronic psychotic as compared with normals and child psychotics. The new experimental measures have also posed many new questions concerning the adjustment of normal and psychotic individuals to fixed-ratio schedules of reinforcement.

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5. Ferster, C. B. and Skinner, B. F. Schedules of Reinforcement, Appleton-Century-Crofts, New York: 1957.

1.4 Exploration of Useful Reinforcers - Grouped Data:

One of our most important observations to date is that some patients respond at very low, erratic rates of response compared to other patients and to unhospitalized individuals. Since low, erratic rates of response are characteristic of inappropriate reinforcers, it was necessary to try many different reinforcers with a group of patients to determine whether the low, erratic rate was a general characteristic of the psychotic's behavior or if some reinforcer could be found which would produce a high, even rate for each patient. Such an exploration of reinforcers is also necessary in the attempt to produce enough behavior to study from the patients with very low rates (in order to "gain control" of their behavior), and to determine the best general reinforcer to use in the large-scale investigation of the behavior of chronic and acute psychotics.

The characteristicly low motivation of the chronic psychotic is well-known in hospital and theory. Many have theorized that this low motivation is due to an inability to respond to "social rewards" and "conditioned gratifiers" (conditioned reinforcers). If some social and conditioned reinforcers were included in our screening, these theoretical questions would be clarified. We might expect individual differences in response to a variety of reinforcers and these individual "interest" or "motivation profiles" should prove useful in further diagnosis and research.

A large portion of our experimental time has been spent in this exploration over the past three years. Although we will continue developing new reinforcers, we have completed our major exploration, and can now make some generalizations concerning the effects of a variety of reinforcers on the behavior of chronic psychotics.

Twenty-three male chronic psychotics were studied for 10 hours each (one hour per day) on a one-minute variable-interval schedule of reinforcement for each of the following reinforcers: 1) candy, 2) female nude pictures, 3) male nude pictures, 4) five-cent pieces, and 5) feeding a hungry kitten (see below). Non-reinforcement or experimental extinction was the 6th condition. The extinction sessions were run in a room that the patient had never before entered so that in cases where the patient's responding did not generalize to the new room this condition was more similar to what has been called an "operant level" by Skinner.

These results were compared with the rates of response of twelve psychotic children responding for candy reinforcement, eighteen normal dogs responding for a meat-grain mixture, and eighteen normal attendants responding for five-cent pieces and in experimental extinction. All reinforcements were delivered on the same one-minute variable-interval schedule. The experimental room was identical for psychotic adults, children and normal individuals.

The dogs pressed a panel instead of pulling the knob used with the human subjects, but all other experimental conditions were identical (except the reinforcer).

Consider Figure 4, where the grouped results are presented. Ten frequency distributions, plotted in terms of the percentage of subjects in each class interval, of the median number of responses per hour for the first ten sessions are presented for each group of subjects under each experimental condition. There are seven class intervals comprising a modified logarithmic scale with refusals to enter the experimental rooms (REF.) and zero responses per hour (0) treated as separate class intervals. The interval labelled (1) contains all median responses per hour from 1 through 9.9. The interval labelled (10) contains medians from 10 through 99.9, that labelled (100) contains medians from 100 through 999.9, that labelled (1000) contains medians from 1000 through 9,999.9, and that labelled (10,000) contains all medians above 10,000. The distributions are labelled as follows: Psychotic adults in extinction (PA EXT), responding for five-cent pieces (PA 5¢), responding to feed the hungry kitten (PA FK), responding for female nude pictures (PA FN), for male nude pictures (PA MN), and for candy reinforcement (PA CAN). Psychotic children responding for candy (PC CAN). Normal dogs responding for meat and grain (ND MG). Normal adults responding for five-cent pieces (NA 5¢) and in extinction (NA EXT).

Consider first the extinction distributions for the chronic adult patients (PA EXT) and the normal attendants (NA EXT). Note that in this experimental situation where the subjects may refuse to participate in the experiment, the normal individuals all refused to come to the experimental rooms before ten hours of extinction had been collected. Most refused within 3 sessions. Only 10% of the patients refused during extinction. This suggests that the patients are either more docile, more accepting, more institutionalized, less able to adjust rapidly to experimental extinction, or perhaps they have nothing better to do. However, a comparison of the patients' extinction distribution with their distribution for candy reinforcement (PA CAN) shows a clear-cut effect of the reinforcement in increasing the rates of response, so this high extinction rate or high operant level of the chronic psychotic cannot explain the higher rates obtained during reinforcement.

Expl.

The rates of response shown in the distributions for normal adults responding for five-cent pieces (NA 5¢), normal dogs responding for meat and grain (ND MG), and psychotic children responding for candy (PC CAN) are representative of the rates obtained from lower organisms responding on the one-minute variable-interval schedule of reinforcement by other investigators.

Note that the distribution of rates from the chronic psychotic adults most similar to these "normal" distributions is the distribu-

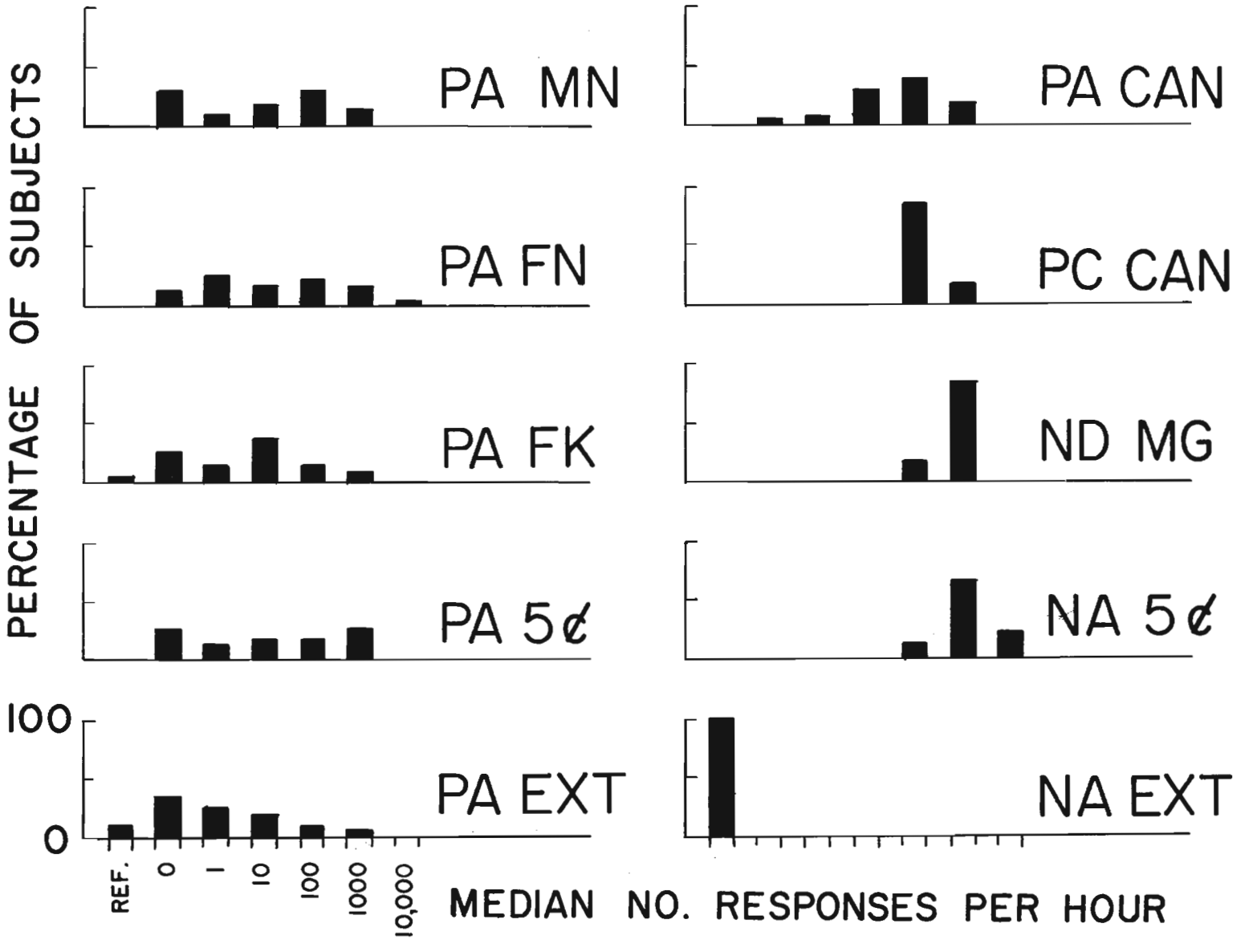
PERCENTAGE OF SUBJECTS
PA MN
PA CAN
PA FN
PC CAN
PA FK
ND MG
PA 5¢
NA 5¢
100
0
PA EXT
NA EXT
REF.
0
1
10
100
1000
10,000
MEDIAN NO. RESPONSES PER HOUR

FIGURE 4

tion of rates of response for candy reinforcement (PA CAN). This means that, even though some chronic psychotic adults respond at low rates for candy, candy is still the best general reinforcer to use with chronic psychotics that we have discovered to date. It is more logical to compare behavior maintained in chronic psychotic adults with candy reinforcement to behavior maintained in normal adults with five-cent pieces than it is to compare the behavior maintained in chronic psychotic adults by five-cent pieces (PA 5¢) with the behavior maintained in normal adults by five-cent pieces. This is an important point and should not be neglected in future research. To compare behaviors generated and maintained in both chronic psychotics and normal adults by money is similar to comparing behavior maintained in dogs and normal adults by money reinforcers. In cross-species comparisons the best reinforcer should be used for each species. Ideally the reinforcers should be previously calibrated to produce similar distributions of rates of response. In comparing institutionalized individuals with non-institutionalized individuals, and psychotic individuals with non-psychotic individuals, the same precautions should be taken.

In comparing the distributions of rates of response for the male chronic psychotics responding for female nude pictures (PA FN) with the rates maintained by male nude pictures no differences were observed in these grouped data. This suggests that the interest of chronic psychotics for homosexual pictures is as strong as their motivation for heterosexual pictures. This apparent homosexuality could be explained by their long hospitalization in a homosexual environment or there may be some basic homosexual tendencies involved in the etiology of their psychoses. However, there were no significant correlations between the total years hospitalization for mental illness and the rates of response for male or female nude pictures using Kendall's rank correlation coefficient (Tau), suggesting that if the homosexual interest developed within the hospital, it developed within the first year of hospitalization. Further research with institutionalized and non-institutionalized normals (prisoners) would clarify this point.

Note that the distributions for the "conditioned reinforcers" (male nudes, female nudes, feeding the hungry kitten, and the five-cent pieces) tend to be bi-modal in comparison to the distribution of rates for the chronic psychotics responding for candy reinforcement. This supports the hypothesis that, in general, chronic psychotics have lost the ability to respond for conditioned reinforcers. Analysis of the individual profiles of response to the different reinforcers (see section 1.5) has shown that this generality (drawn from grouped data) should be used with extreme caution when applied to individual patients. Here again, there were no significant correlations (using Kendall's Tau) between years hospitalization and rate of response, suggesting that the loss of the ability to respond for conditioned reinforcers is not related to the duration of institutionalization, although we would again like to have institutionalized normal data for comparison.

As we have stated, there were no significant correlations between total years hospitalization and the rate of response for any of the reinforcers. Psychiatric diagnosis does not relate to the operant rate of response for any of the reinforcers as has been stated in previous reports and as can be seen in section 1.5 which follows. As we have previously reported for a restricted group of patients[6] there are significant correlations between ratings of the patients' ward behavior and their rate of response for candy reinforcement (Rho = +.82, $p < .001$). The correlations for larger groups of patients and for more reinforcers are presented in Table 2. These correlations are probably lower than the earlier reported correlation for two reasons: 1) the Spearman rank correlation coefficient produces higher values than Kendall's Tau when both are computed from the same set of rankings (Rho = +.82 when Tau = +.67, and Rho = +.62 when Tau = +.39, see Siegel's Nonparametric Statics, McGraw-Hill, New York: 1956, P.219), and 2) the correlation reported earlier was made between rates of response and ward behavior ratings taken at the same time, whereas the correlations in Table 2 were made between rate of response measures and ward behavior ratings taken at necessarily different dates, so that variations in the degree of the patients' symptoms would serve to reduce the correlations presented in Table 2. There should be no question regarding the appropriateness of the statistic used, because Kendall's Tau is non-parametric, and as far as we know, we have violated no assumption in its application. Since many of our "N"'s are very small, we plan to continue to use Kendall's Tau in preference to other correlation procedures because it is non-parametric and provides significant computations for all values of "N".

From a consideration of Table 2 it is clear that operant rate of response for a wide variety of reinforcers correlates lowly, but significantly, with the adjustment of the patients to the hospital environment. The more regressed patients respond at lower rates, with a longer amount of time spent in psychotic distractions during each session, and with longer mean inter-response times.

Consideration of Table 2 also permits an evaluation of the different reinforcers with respect to their relative efficiency in predicting hospital adjustment. Reinforcement with male nude pictures produces the highest and most significant correlations with ward behavior for male patients. Why this is so is not quite clear to us. It might have something to do with the degree of homosexual

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6. Lindsley, Ogden R. Progress Report I, Research Grant MH-977, National Institute of Mental Health, National Institutes of Health, Public Health Service, Behavior Research Laboratory, Harvard Medical School, Waltham, Massachusetts, June 1956.

Table 2

Summary of the Kendall rank correlation coefficients (Tau) between the median of the first ten weekly ratings of ward behavior using the Lucero-Meyer Behavior Scale and the medians of three measures of the rate of response for the first ten sessions of one-minute variable-interval reinforcement with five different reinforcers. The correlations of the ward behavior ratings with the median rate of response measures during the first ten extinction sessions are also presented. The P value of the significance (two-tailed test) of each correlation coefficient is entered in parentheses under each coefficient. The number of patients involved in each correlation is entered under "N". All patients were male chronic psychotics.

Reinforcer	N	Responses/Hr.	ΣIRT>10"	Mean IRT>10"
Candy	34	Tau = +.30 P = (.02)	-.34 (.005)	-.30 (.01)
Male Nudes	30	+.49 (.0001)	-.50 (.0001)	-.42 (.001)
Female Nudes	31	+.46 (.0003)	-.38 (.003)	-.33 (.009)
5¢ Pieces	28	+.40 (.003)	-.30 (.03)	-.34 (.01)
Feeding Kitten	23	+.28 (.06)	-.11 (.47)	-.16 (.28)
Extinction	26	+.33 (.02)	-.21 (.13)	-.25 (.07)

adjustment, ability to tolerate "homosexual shock," etc. Until we can obtain objective measures of these implied variables we must withhold interpretation. Reinforcement with female nude pictures is the second best predictor with money reinforcement and candy reinforcement tied for third place. It is important to note here that, although reinforcement with male and female nude pictures produced higher correlations with ratings of ward behavior than reinforcement with candy, the rates of response themselves were lower than with candy reinforcement. Also the differences in the correlations and their significances were not too great. This means that if we want to predict ward behavior we might get higher correlations using male or female nude pictures as reinforcers than by using candy reinforcement. But, if we want the most useful operant behavior, without prior knowledge of individual differences, candy is still the best general reinforcer for use with chronic adult psychotics. The extinction rate has more predictive value than the rate of response to feed the kitten which fell in last place with correlations that cannot be considered predictive or significant.

Consideration of Table 2 also permits an evaluation of the three measures of rate of response (median responses/hour, ΣIRT >10", and mean IRT >10") with respect to their relative efficiency in predicting hospital adjustment. The median number of responses/hour was perhaps the most efficient since, in 4 out of 6 cases, it produced higher and more significant correlations than did the median ΣIRT >10" and the median mean IRT >10". The median ΣIRT >10" ranks in second position since it is the most predictive for reinforcement with candy and male nudes, and is superior to the median mean IRT >10" in 3 cases.

In summary, the grouped data show that candy is the best general reinforcer (of those we have investigated) to use in further research. The distribution of rates it produces in chronic adult psychotics, although skewed to the left in comparison with the distributions of psychotic children responding for candy, normal dogs responding for meat and grain, and normal adults responding for money, shows useful rates with most of the patients. Normals tend to refuse to participate in the experiment during experimental extinction, whereas patients do not. Many patients extinguish very slowly, if at all. Psychotic children respond at higher rates for candy reinforcement than do psychotic adults, their distributions approximating those of normal dogs for meat and grain, and normal adults for money. The conditioned reinforcers produced lower rates of response and bi-modal distributions in comparison with the unconditioned reinforcer (candy) with chronic psychotic adults.

1.5 Exploration of Reinforcers - Individual Motivation Profiles:

One important advantage of the free operant method of behavioral investigation is that the data are usually so reliable and sensitive that significant results can be obtained from the intensive investigation of single individuals. This advantage is doubly important in the analysis of psychosis, where the problem might be considered as one of individual differences. The clinician instinctively knows this, as the large number of individual case histories in the psychiatric literature testify. Since our data can be treated individually without losing significance and reliability, and since we have studied a large enough group of subjects under standard conditions to permit conclusions concerning groups of psychotics, we are in a position to compare the individual treatment with a grouped treatment of our data.

In the previous section (1.4) the conclusions drawn from the grouped data of 23 chronic psychotics in an analysis of the effects of 5 different reinforcers were presented. The grouped data supported some of the theoretical generalizations concerning the motivation of a population of chronic psychotics. In this section the same results are treated individually, and quite different conclusions are made concerning the behavior of individual psychotics. We feel that the conclusions drawn from grouped data are useful if one must make blind predictions concerning groups of patients with very little information concerning the individual behavior of each patient. However, we consider individualized treatment essential in the diagnosis and prognosis of individual patients and above all in the analysis of psychosis itself. These data concerning the responses of chronic psychotics to several different reinforcers provide a "case history" to show the different kinds of conclusions that will be made from an individualized treatment compared to a grouped treatment of the same set of data.

Figures 5 through 9 present individual rate-of-response profiles for each of the 23 patients under each experimental condition. The median number of responses per hour for each reinforcing agent are plotted on a logarithmic scale with the categories of "zero responses per hour" and "refusal to enter the experimental room" entered as separate points on the bottom of the scale. The reinforcing agents are ordered along the abscissa, from left to right, in order of the median number of responses per hour for the group of 23 patients. The median rate during extinction (EXT) was 3 responses per hour. The median rate to feed the kitten (FK) was 15 Resps/Hr. The median rate for five-cent pieces (5¢) was 41 Resps/Hr. For female nude pictures (FN) it was 74 Resps/Hr., and for male nude pictures (MN) it was 92 Resps/Hr. The median rate for candy reinforcement (CAN) was 201 Resps/Hr. These group medians are plotted on Figure 5 as heavy black circles connected by a double

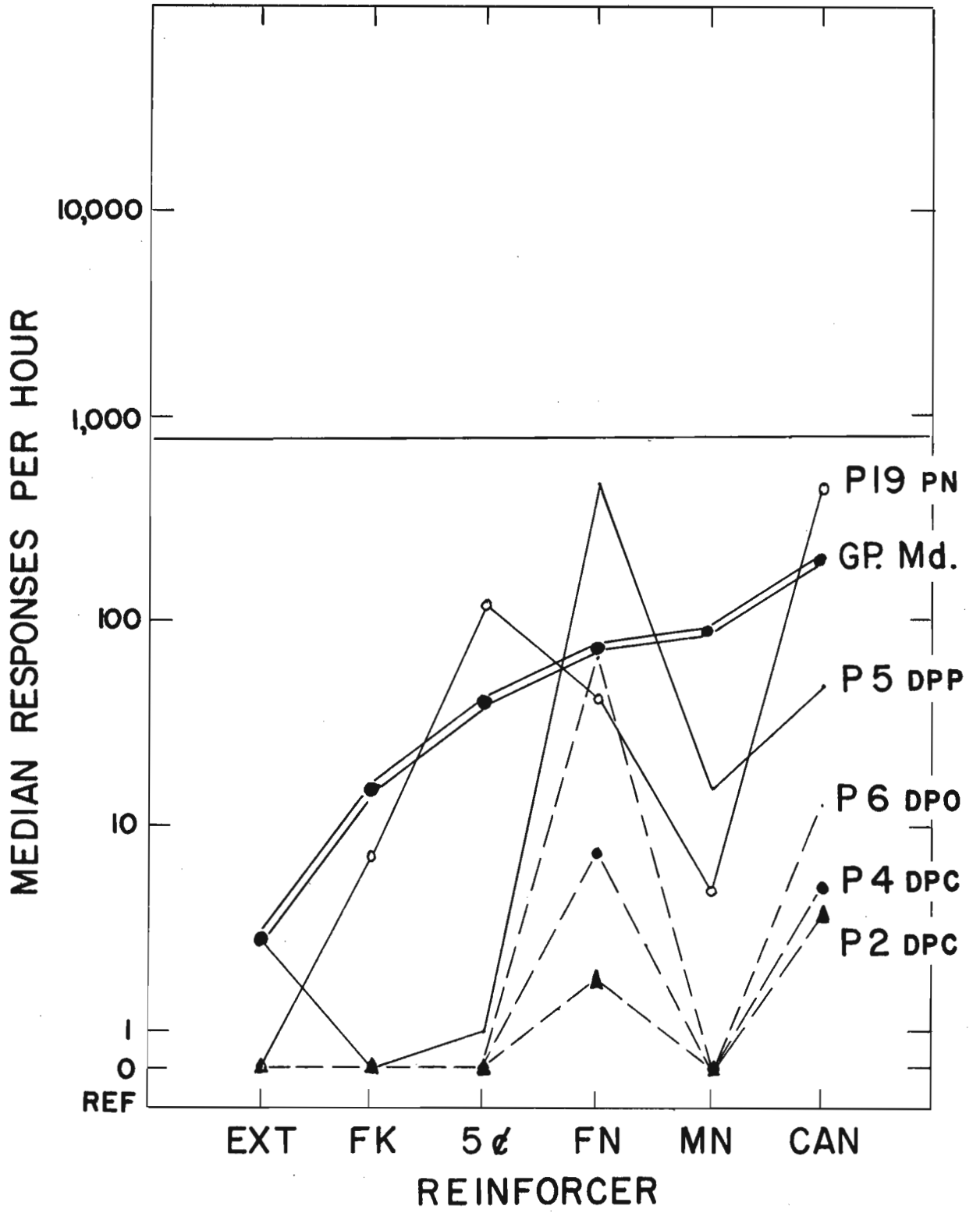
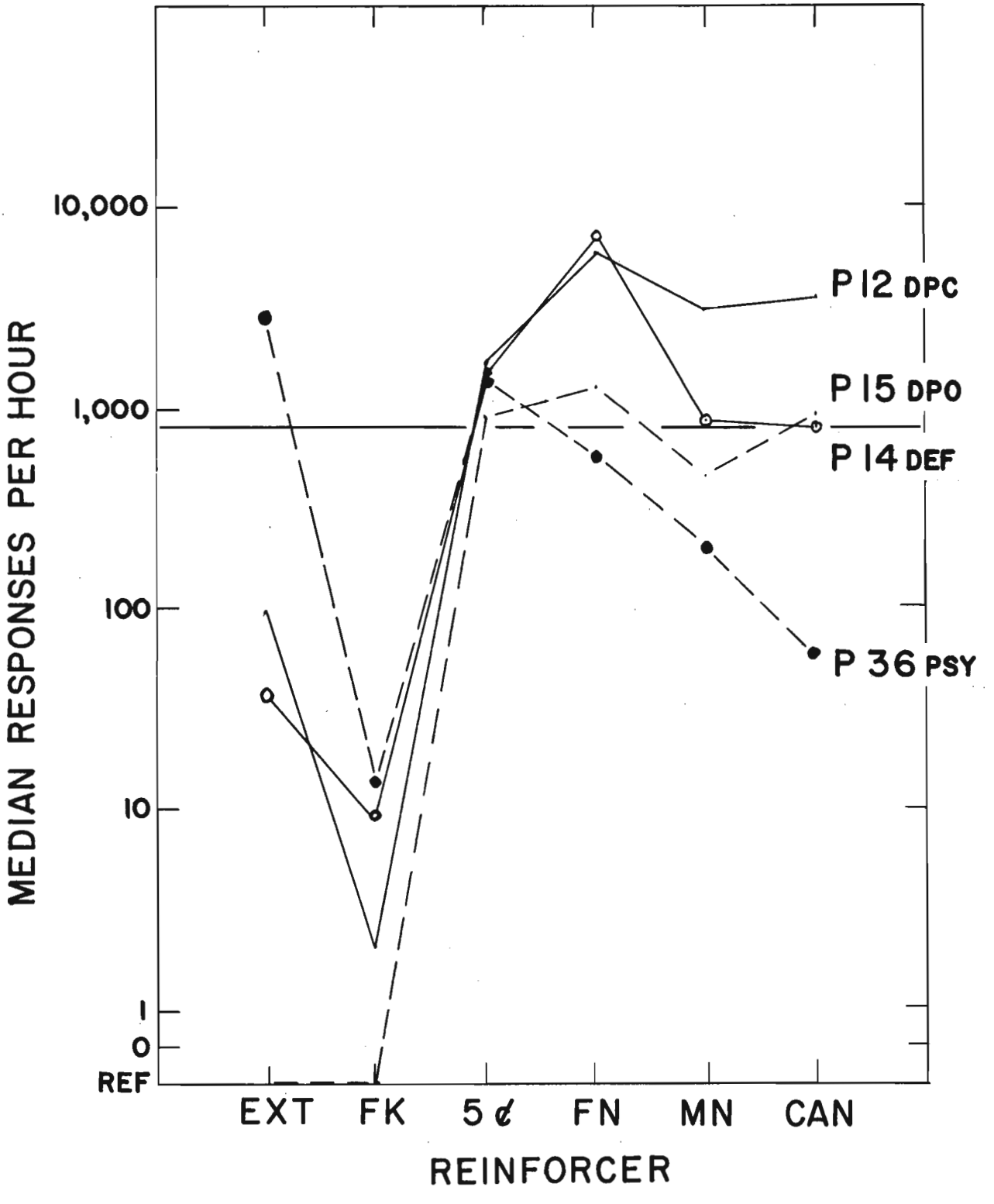

MEDIAN RESPONSES PER HOUR
10,000
1,000
100
10
1
0
REF
P19 PN
GP. Md.
P5 DPP
P6 DPO
P4 DPC
P2 DPC
EXT
FK
5¢
FN
MN
CAN
REINFORCER

FIGURE 5


MEDIAN RESPONSES PER HOUR
10,000
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10
1
0
REF
EXT
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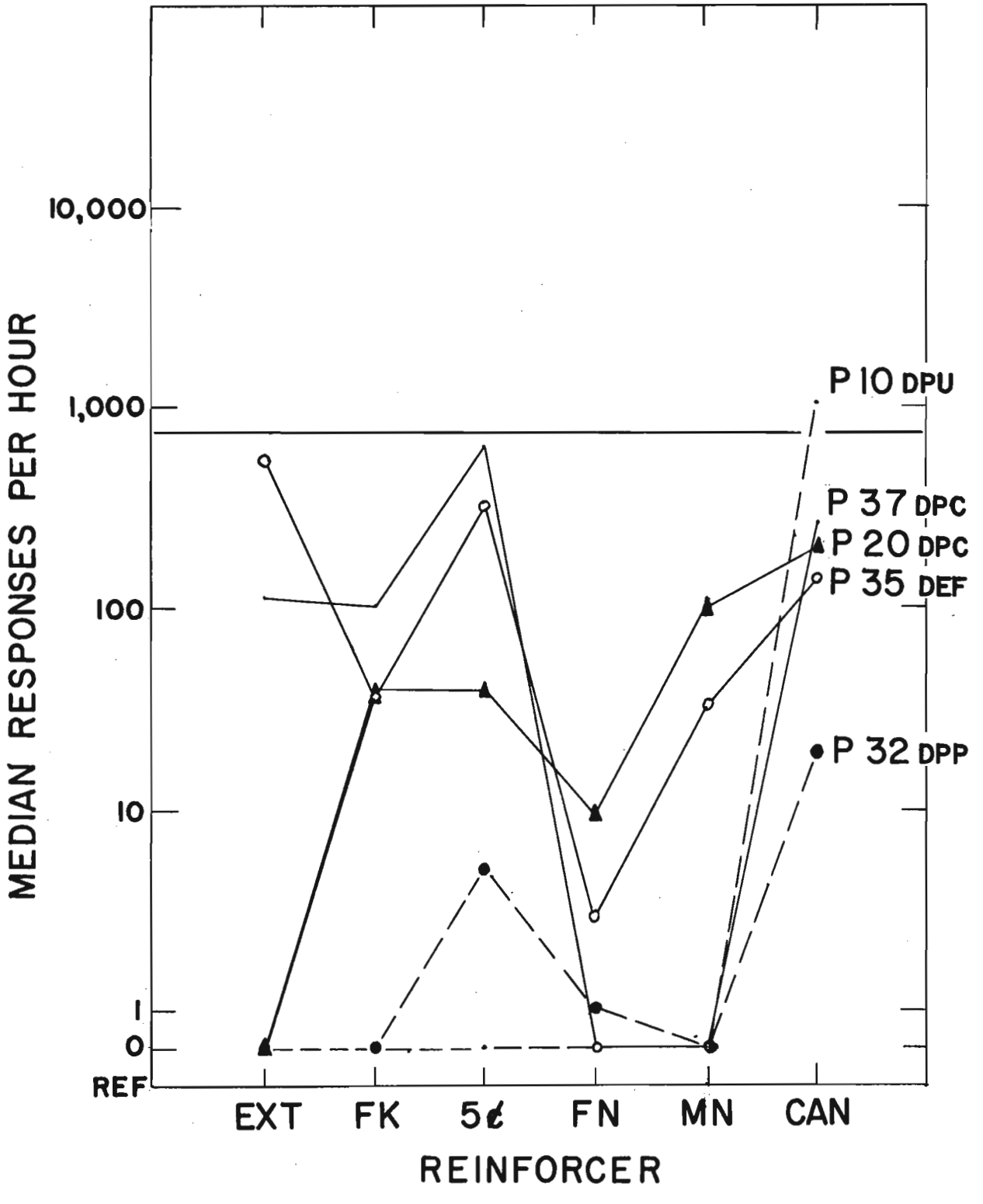
FN
MN
CAN
REINFORCER
P 12 DPC
P 15 DPO
P 14 DEF
P 36 PSY

FIGURE 6


MEDIAN RESPONSES PER HOUR
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1,000
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1
0
REF
EXT
FK
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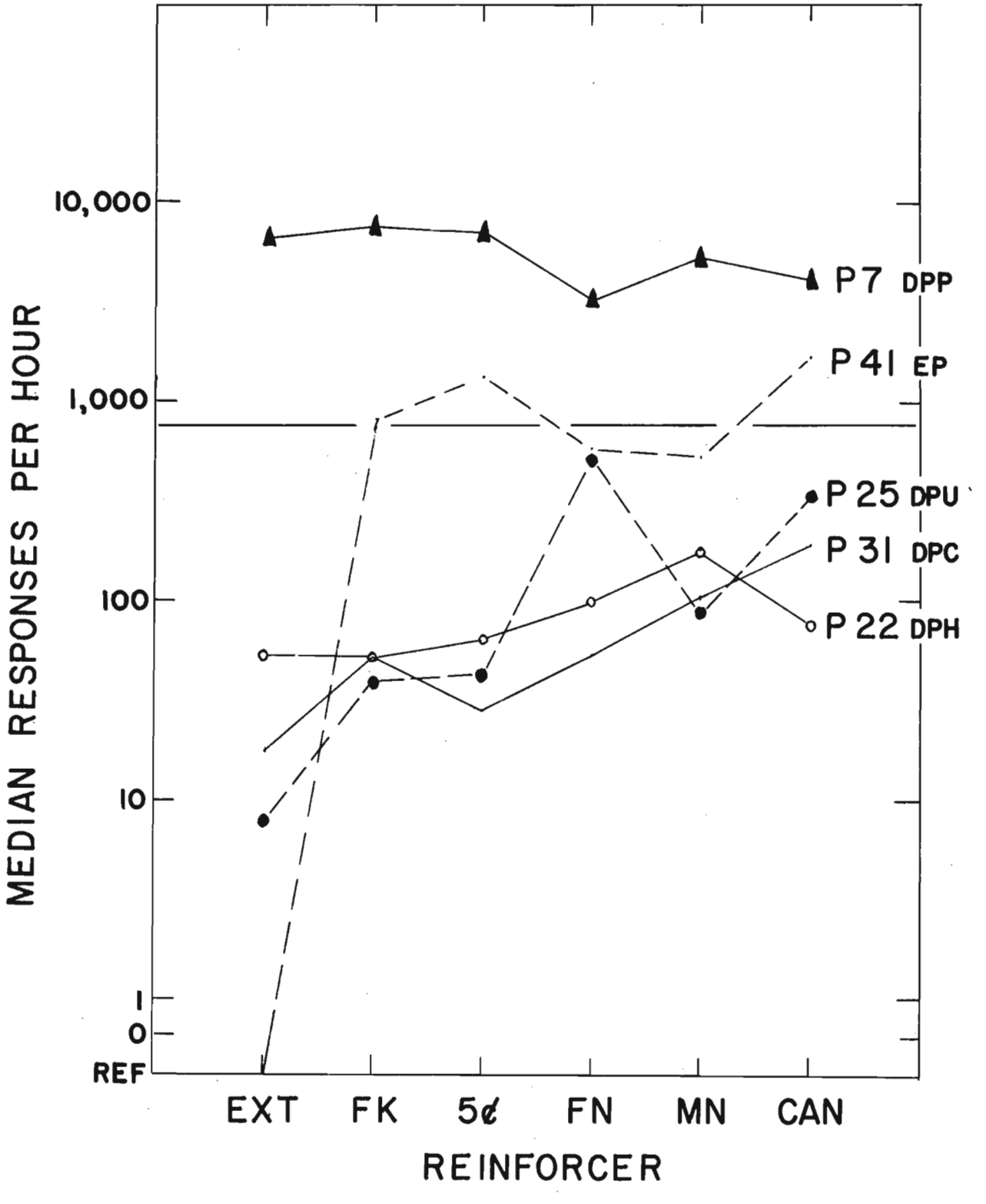
FN
MN
CAN
REINFORCER
P 10 DPU
P 37 DPC
P 20 DPC
P 35 DEF
P 32 DPP

FIGURE 7


MEDIAN RESPONSES PER HOUR
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REINFORCER
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P 41 EP
P 25 DPU
P 31 DPC
P 22 DPH

FIGURE 8

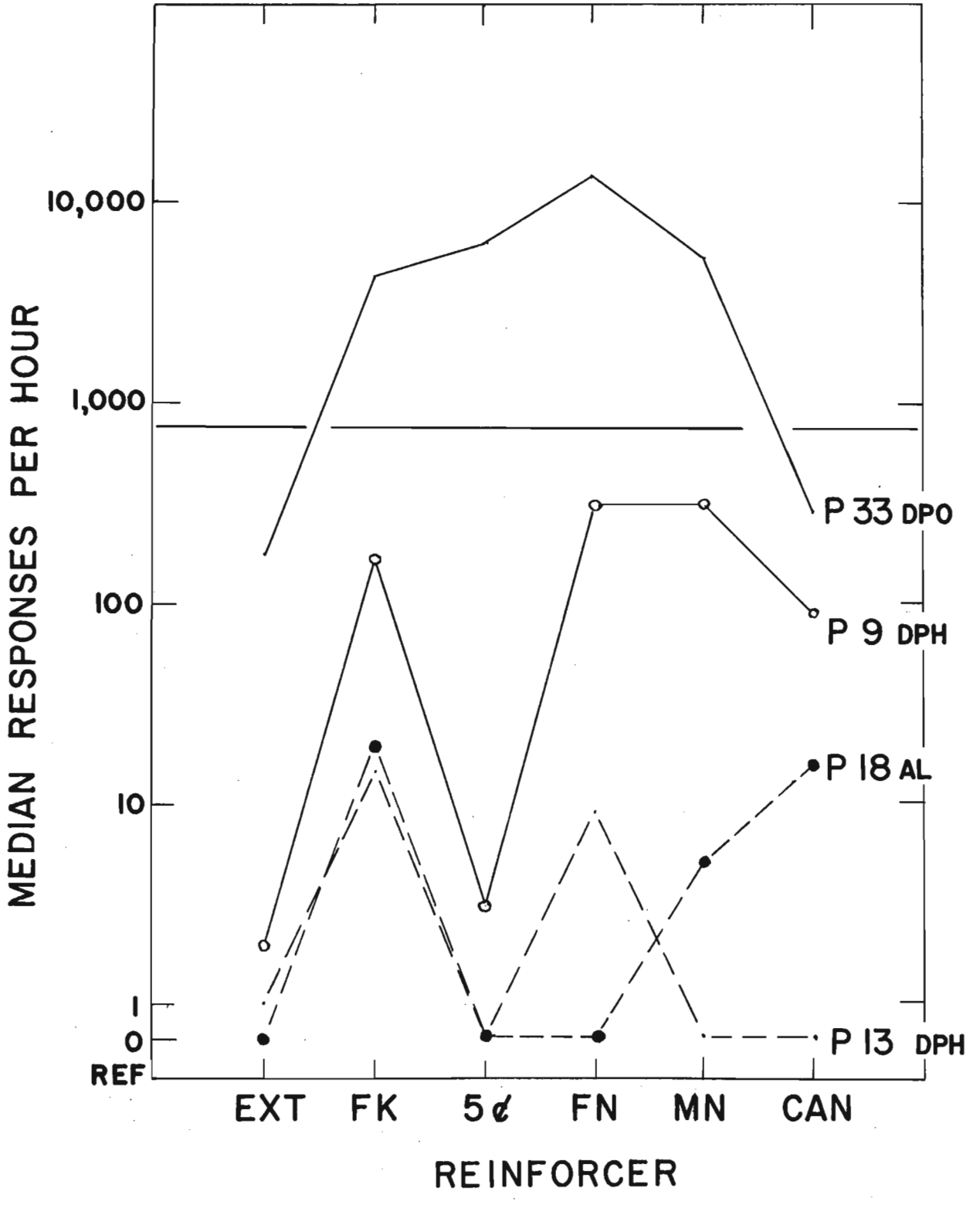
MEDIAN RESPONSES PER HOUR
10,000
1,000
100
10
1
0
REF
P 33 DPO
P 9 DPH
P 18 AL
P 13 DPH
EXT
FK
5¢
FN
MN
CAN
REINFORCER

FIGURE 9

line. The line drawn across each graph at approximately 800 Resps/Hr. represents the lowest rate at which any normal responded for five-cent pieces, and can be considered a crude "normal cut-off point". In all cases (except extinction) the reinforcements were presented on a one-minute variable-interval schedule. The different profiles are labelled with the patients' laboratory number and an abbreviation of the patients' psychiatric diagnosis. The abbreviations are: PSY - psychosis, undifferentiated type; PN - psychoneurotic; EP - psychosis with epilepsy; AL - Alcoholic psychosis; DPU - Dementia Praecox, undifferentiated type; DPP - Dementia Praecox, paranoid type; DPC - Dementia Praecox, catatonic type; DPH - Dementia Praecox, hebephrenic type; DPO - Dementia Praecox, other types; and DEF - Mentally Defective with psychosis. The group medians for all 23 patients are labelled "GP Md".

A glance through the five graphs will show that many of the patients have quite different patterns or profiles of response to the different reinforcers. These individual differences in the profiles are so great that it is very difficult to group them into clusters of similar profiles. We have done the best we could in Figures 5 through 9. Figure 5 contains the group median profile and the profiles for five patients that responded at low rates during extinction, at higher rates for the conditioned reinforcers and at their highest rates for female nudes (FN) and candy (CAN). All 5 patients responded at lower rates for male nudes (MN) than they did for female nudes (FN). They might be described as having a low over-all motivation with less homosexual than heterosexual interest.

In Figure 6 are presented the profiles of 4 patients who responded at relatively high rates of response for five-cent pieces, female nudes, male nudes and candy, but at a very low rate to feed the kitten (in three cases below their extinction rate). These patients might be loosely described as having little succor, or as selfish. All 4 responded at slightly lower rates for male nudes than for female nudes. They clearly responded at high rates for the five-cent pieces, showing they were able to respond for one type of conditioned reinforcer.

Figure 7 contains the profiles of 5 patients who responded at low rates for female nude pictures (FN). Two of these patients responded at higher rates for male nudes (MN) showing a significant homosexual pictorial interest. Both of these patients had been observed engaging in homosexual practices within the hospital. Actually the profiles of P10 and P32 might have been placed in Figure 5, since they are very similar to the profiles presented there, but they were presented in this figure to facilitate reading the graphs.

Figure 8 contains the profiles of 5 patients who responded at moderately high rates for all the reinforcers used. Three of these

patients (P7, P31 and P32) also responded at high rates during extinction. When extinction was continued longer than ten experimental sessions, the rates of response of all three of these patients slowly dropped to low values. Therefore, these 3 patients are patients who extinguish slowly.

Figure 9 contains the profiles of 4 patients with quite different profiles. P33 responded at a very high rate for all the reinforcers except candy. P9 responded at a high rate for all the reinforcers except five-cent pieces, showing an inability to respond to the most purely conditioned reinforcer. P18 responded for male nudes (MN), candy (CAN) or to feed the kitten (FK) only, and P13 responded only for female nudes (FN) or to feed the kitten (FK).

In summary, the individual profiles of rates of response for the 5 different reinforcers show at least 8 significantly different patterns of motivation. These patterns - low altruistic interest (FK), low sexual interest (FN and MN), low rate for conditioned reinforcement (5¢), low heterosexual interest (FN), low homosexual interest (MN), low candy motivation (CAN), low over-all motivation (FK, 5¢ FN, MN, and CAN), and a high extinction rate (EXT) - should prove useful in diagnosis and research. These individual profiles seem to be very stable and can be altered by the administration of certain drugs. (Chlorpromazine has sharply reduced the rate of response for male and female nudes without altering the rate for candy reinforcers in two patients.)

Some of the individual profiles support theories of motivational deviation described by many clinicians - a specific loss in the effect of socially conditioned reinforcers (money), low succor or altruism (feeding the kitten), and sexual deviations (male and female nudes). It may be important to note that our grouped data support theories presented by individuals who have engaged in group research and prediction and our individual profiles support notions presented by clinicians experienced in dealing with individual psychotics. Some of the controversies that have raged about the etiology and nature of psychosis might be clarified if we asked, "Are you talking about a type of patient, or psychotics in general?"

It is our feeling that unless one is primarily interested in hospital biometrics, it is much safer to utilize research designs that will permit the individual analysis of data when one investigates the therapy and nature of psychosis. When we are able to group psychotic patients into homogeneous categories with respect to behavior anomalies before we proceed with our research, we can then use the more economical small group research designs. However, much research will have to be done before this information will be available.

In this connection it is interesting to note that the psychiatric diagnoses (labelled on each profile) would have been very poor predictors of the level or profile of motivation we recorded from our patients.

1.6 Analysis of Immediate Use of Reinforcer:

Since the majority of our patients are not verbally coherent, we have no easy way of determining "what the reinforcement means to the patient." Even if the patients were coherent, we would be caught up in the extremely difficult analysis of the patients words, which in themselves might "mean" different things to the patient than they do to us. Our way of measuring the "meaning" or "value" of the reinforcer to the patient is to measure the frequency of the behavior he will emit in order to get the reinforcing agent. The advantages of this type of objective measurement are obvious and we feel they have been demonstrated in the success of our research to date.

There are other responses of the patient to the reinforcing agent that we can record. Although it is less objective than our automatic recording of the patients' rates of knob-pulling to obtain the reinforcer, we can observe what the patients do with the reinforcers after they have been delivered. We have done this with respect to candy reinforcers delivered on a one-minute variable-interval schedule. For analysis we broke the patients into two groups: 1) those who ingested each piece of candy as it was delivered, and 2) those who hoarded some of the candy and took it back to the wards with them. We have not had the facilities to observe what the "hoarder" patients did with the candy when they were back on the wards. We do know that some of them saved it to eat later, some gave it to other patients, and others used it to purchase favors from other patients. One patient was once observed throwing some of his candy down the toilet.

Table 3 presents three rate-of-response measures together with the median age, years hospitalization and ward behavior rating for these two groups of patients, the ingesters and the hoarders. Note that the hoarders had approximately the same median age and were hospitalized about the same length of time as the patients who ingested the candy immediately. The hoarders responded at significantly higher rates and spent ~~more~~ less time in pauses greater than ten seconds than did the ingesters. Prior to this observation one might have argued that the patients who ate the candy immediately had a greater "motivation" for the candy and would respond at higher rates to get it. However, this was not the case; the hoarders were less-disturbed

Table 3

Patients that ingested all their candy compared with those that saved some of their candy with respect to: 1) the median number of responses per hour (R/Hr.), 2) the median sum of the inter-response times greater than ten seconds (ΣIRT>10") and 3) the median number of inter-response times greater than ten seconds (#IRT>10") - for the first 10 hours of reinforcement with candy on a one-minute variable-interval reinforcement schedule, 4) the patient's age, 5) the total years hospitalization, and 6) the patient's ward behavior as rated on the Lucero-Meyer rating scale (LMBS). P values obtained from two-tailed median tests are entered between significantly different entries.

	N	%	R/Hr.	ΣIRT>10"	#IRT>10"	AGE	YRS. HSP.	LMBS
Patients that ingested each candy	18	66	68	52'	25	40	16	1.9
P Value			.01	.07	---	---	---	.04
Patients that saved some candy	9	33	772	38'	47	39	19	3.2

patients who responded at high rates and received higher ratings of ward behavior as measured by the Lucero-Meyer behavior scale. The ratings given in the table are medians of the median rating of the first ten ratings made at weekly intervals by attendants who were ignorant of the patients' operant behavior.

The low rates of response of the ingesters are not caused by the time in reaching for the candy and placing it in their mouth after each reinforcement because the recording apparatus is inoperative for 5 seconds after each reinforcement. This time is automatically "deducted" from each record and does not appear in the rate of response calculations. The 5 seconds "time-out" after each reinforcement is ample for the ingestion of the candy in most cases. Also, a large percentage of the very long pauses in responding taken by the ingesters do not occur immediately after reinforcement, so these long pauses could not be attributable to the presentation or ingestion of the candy. Rather the very long pauses seem to be a property of severe psychosis which also is related to an inability to hoard. Additional evidence for this interpretation is provided by the observation that the ingesters displayed significantly more regressed behavior on the wards.

1.7 Feeding a Kitten - a Social Reinforcer:

We have long planned to systematically investigate elementary forms of social behavior. Our approach is to start with the simplest social situations that we can instrument and then slowly proceed with our analysis to more complex situations more in accord with what most psychologists mean by "social." In our search for useful reinforcers we felt that some of the patients might not respond to produce a positive reinforcer for themselves, but they might respond to produce one for another organism. In non-technical terms, even though they have "guilt," they might respond to give "charity" or "help" to another organism. Also, it is a common hospital observation that some of the sickest mental patients will not feed themselves, but will not let an animal pet die - they continue to feed it long after they won't feed themselves.

In an attempt to utilize such reinforcing properties in our investigations, we conditioned a small, hungry kitten to drink milk when a dipper was automatically presented. The kitten was in a cage with a plexi-glass front behind the manipulandum panel and was visible to the patients as they responded inside one of the experimental rooms. Twenty-three patients responded for ten hours each on a one-minute variable-interval schedule of reinforcement. Each time a patient was reinforced, the lights in the room went out and a dipper of milk was presented to the hungry kitten for five seconds.

The kitten was well conditioned, and in our many observations we never observed the kitten refusing to drink the milk. The reinforcement to the patient was observing the kitten drinking milk that the patient's responding had produced for the kitten. The kitten soon learned to face the patient and "meow" and scratch the back of the window with his paw to "beg" for the milk except when it was drinking from the dipper. Several of the patients talked to the kitten while they were responding, saying things like, "Pretty little kitty. You're hungry, I'll get some milk for you...There, isn't that good..Ha, ha, ha...That's good, pretty little kitty...Ha, ha, ha ..." Two patients swore continually at the kitten and struck the plexi-glass window with the chair. One paranoid patient kept saying that the kitten was the devil and that it was saying bad things about him and had gotten him into the hospital, etc.

If the kitten was not hungry when placed in the apparatus, the patients who had responded to feed the kitten stopped responding. This showed that it was the kitten's drinking behavior that was reinforcing to the patients and not just the presentation of the dipper or the darkening of the room. Because the behavior of the kitten (another organism) is what reinforced the patients, we call this a social reinforcer - a very elementary form of social behavior. It is true that one organism involved is infra-human, but, using Skinner's definition[7], the situation is definitely social.

Three of the patients (13%) responded at a higher rate to feed the kitten than they did for any of the other reinforcers. One of these had responded at a zero rate of response for the other reinforcers, so this was the only patient who gave the expected result - he responded to produce a positive reinforcer for another organism when he would not respond to produce a positive reinforcer for himself. Seven patients (30%) responded to feed the kitten at rates that were above their extinction rates, showing that feeding the kitten was reinforcing to them. Thirteen patients (57%) responded at rates equal to or below their extinction rates when feeding the kitten, showing that feeding the kitten was either non-reinforcing or aversive to them.

In order to show more clearly that feeding the kitten could act as a reinforcer with some patients, we reinforced two patients (P-9 and P-33) for 50 hours on the one-minute variable-interval schedule of reinforcement followed by 40 hours of extinction. During extinction, the kitten's milk-dipper was made inoperative so that

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7. Skinner, B. F. Science and Human Behavior. New York: Mac Millan, 1953, p. 297-304.

the kitten did not receive any milk during extinction. The kitten was hungry, however, and continued to "meow" and scratch at the plexi-glass window throughout these extinction sessions. These results are presented in detail in Figure 10 where the responses per hour are plotted against experimental sessions for each patient. P-9 responded at rates around 300 responses per hour with a range of about 200 responses per hour. P-33 responded at rates around 5,000 responses per hour with a range of about 8,000 responses per hour. Note the seven days of acquisition shown by P-9 and the rhythmical "cycles" in rate of response shown by both patients. We have noted these rhythms in the behavior of many patients responding for all types of reinforcement. To date, we have not been able to relate these rhythmical changes to any other variables other than observations of ward behavior. The important point shown in Figure 10 is that the knob-pulling behavior of both patients was maintained at relatively high rates for 50 experimental sessions by reinforcement with the kitten's drinking behavior. When the kitten did not drink (extinction), both rates of response fell to significantly low values within 20 sessions, generating characteristic extinction curves.

In summary, 13% of the patients responded at their highest rate of response to feed the kitten, 30% responded at rates above their extinction rates, showing that feeding the kitten was reinforcing to them also, and 57% of the patients responded at rates equal to or below their extinction rates, showing that feeding the kitten was not reinforcing to them. The reinforcement of feeding the kitten maintained the behavior of two patients for 50 experimental sessions (10 weeks) at relatively high rates of response, followed by a reduction in rate in approximately 20 extinction sessions.

1.8 Behavior Data Card:

Initially we wrote important observations of the patients' behavior and counter readings, etc., directly on the cumulative records of each experimental session. Since the foot-long cumulative records were so troublesome to handle, later statistical analysis was very difficult. Also, as the research progressed, more and more information was being written on each record, until the final result was very confusing.

In an attempt to overcome this difficulty, the 8 x 5 inch behavior data card shown in Figure 11 was developed. The front of the card has space in the upper left hand corner for the patient's laboratory number, name, and the initials of the experimenter. Immediately under these entries is space for printing the date and time that the experimental session was finished by inserting the card in a small IBM time clock (Type 780). The cumulative record-

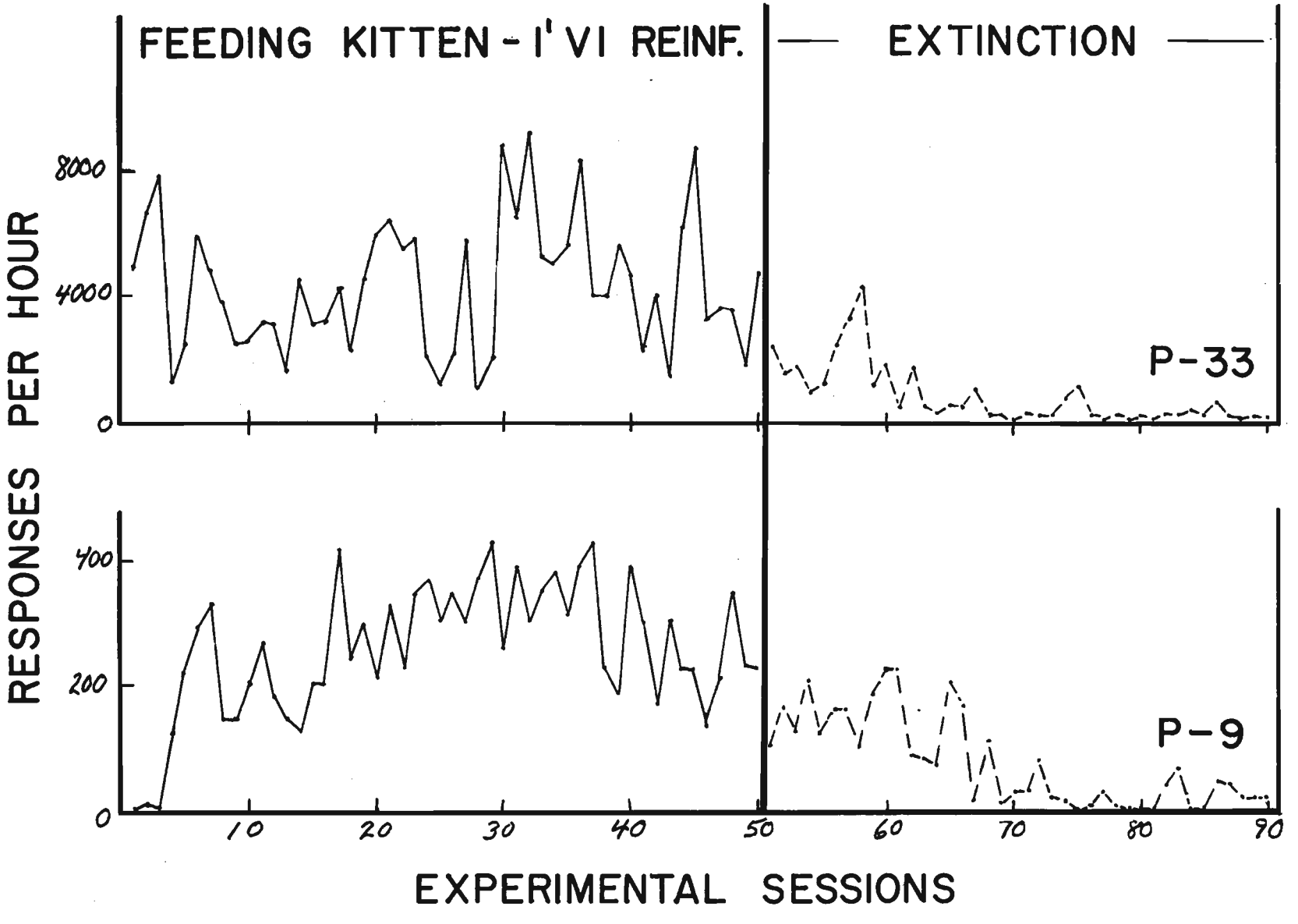
FEEDING KITTEN - I' VI REINF.
EXTINCTION
RESPONSES PER HOUR
8000
4000
0
400
200
0
P-33
P-9
10
20
30
40
50
60
70
80
90
EXPERIMENTAL SESSIONS

FIGURE 10

LAB # | PATIENT'S NAME | EXPTR

DATE | FINISH | TIME

HRS | MIN — DURATION | ROOM | EXPTL. SESSION

APPARATUS FAILURE: _____

WITHDRAWAL REASON: _____

(Room)

R #	R #	R #	R #	TIME AFTER
S^R				TIME BEFORE
SCHED				Σ IRT > 10"
#S^R				# IRT > 10"
# R				M IRT > 10"

RESPONSES: HAND L R, FOOT L R, ELBOW L R, RESPONDING THRU S^R, STEREOTYPY: R # _____ HAND _____

BEHAVIOR IN PAUSES: VERBAL-YELLING, SINGING, WHISTLING, LAUGHING, CRYING, TALKING, NOISES, SILENT _____

MOTOR-DESTRUCTION, PACING, STANDING, SITTING, READING, GESTURING, TINKERING, MAST., UNDRESS, IMMOBILE _____

CONDIT. OF ROOM: SMEAR, DEFECAT, URINAT, VOMIT, PAPER, CLOTHING, S^R LEFT #_____ TYPES _____

COMMENTS: _____

BEH. RES. LAB FORM 1

LEFT WARD: REF. REASON _____

LED, TALKED INTO IT, READILY, JUMPED UP, WALKED AHEAD.

SILENT, SAID _____

APPROACH: REF. REASON _____

LED, TALKED INTO IT, READILY, JUMPED UP, WALKED AHEAD.

SILENT, SAID _____

CLINICAL EXAM: REFUSED, NURSE _____

BODY WT. _____ LBS _____OZ THIN O.K. FAT

TEMP _____ °F RECTAL, ORAL, PULSE _____/MIN

EYES: INF RED WATERY CLEAR BP ___/___ MM.

HANDS: INF CUT DIRTY CLEAN NAILS TRIMMED

GUMS: HEM LES LAC ANEMIC CLEAR

THROAT: INF LES RAW ANEMIC CLEAR

TEETH: ABCESS CAVITIES FALSE NONE

COMMENTS: _____

PTS. LOUNGE: DESTRUCTIVE, ASSAULTIVE, PACING, STANDING, SITTING, READING, GESTURING, IMMOBILE, HALLUCINATING, SILENT, YELLING, SINGING, WHISTLING, LAUGHING, CRYING, SOC. TALKING, NOISES.

RETURN: REF. REASON _____

RESPONDING AFTER EXPT, LED, READILY, JUMPED UP, WALKED AHEAD. SILENT, SAID _____

FIGURE 11

ing is also stamped at the same time, insuring that the behavior data card and the cumulative recording for each experimental session are accurately stamped with the date and time. In the upper right hand corner are spaces for writing the duration of the experimental session, the number of the experimental room in which the session was conducted and the number of the experimental session for this particular patient. The cards are filed by patient laboratory number and the experimental session number, as are also the cumulative recordings.[8] The upper right hand corner also provides space for describing apparatus failures[9] or the reason that a patient might withdraw from the room before the end of the session.

Space on the front of the card is also provided for the number and type of manipulanda used (R#), the reinforcer used (S^R), the number of reinforcements delivered (#S^R), and the number of responses made (#R). Four separate columns for these entries permit the data from a wide variety of experimental situations to be described and recorded. A fifth column is provided for recording the sum and number of inter-response times greater than ten seconds. The reading of the timer that records the total duration of inter-response times greater than ten seconds is entered at "time before" before the experimental session and at "time after" at the end of the session. The difference between these two readings is the sum of the inter-response times greater than ten seconds and is entered in the space labelled "ΣIRT>10". The reading of the counter that

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8. We have found the leatherette legal-size vertical file pockets, manufactured by the Smead Manufacturing Co., Hastings, Minnesota, (File Pocket No. 1-2370E) to be very satisfactory containers for filing the cumulative response records. The pockets are long enough (15 inches) to handle hour-long records without crimping the edges, and the expandable sides and bottom prevent the records from sliding out as they do in standard office-type manila folders.

9. Using our present apparatus and one technician collecting 30 patient-hours of data per day with the help of another technician who constructs and repairs apparatus, we experience approximately 60 apparatus failures (including pen clogging, etc.) and 40 human errors in 1,000 patient hours of data collected over a period of 8 months. Since our recorders run in parallel with the counters, a large percentage of these failures and errors are corrected by analyzing the data, and the experimental design is not threatened.

records the number of inter-response times greater than ten seconds is entered in the space labelled "#IRT >10"," and the mean inter-response time greater than ten seconds can be computed by dividing the ≤IRT >10" by the #IRT >10" and entered in the space labelled "M IRT >10"."

The bottom of the front of the card contains words that may be circled to describe what the experimenter observes when he looks at the patient through the periscope during each experimental session. After "Responses," the experimenter can circle the word describing which extremity the patient used to make his responses. If the patient responded through the 5-second magazine cycle (when no responses are ever reinforced) "responding through S^R" is circled and the reading of a counter which records the number of responses made during this time is entered immediately above these words. If the patient responded in a stereotyped fashion on two or more manipulanda, the pattern of this stereotype is written in the space labelled "R# _____hand _____."

The words describing the particular behavior (both verbal and motor) of the patient when he is not responding may be circled after "behavior in pauses." These words describe the particular psychotic symptoms that the patients engage in when they are not pulling the knobs. Additional descriptions may be entered in the space labelled "comments" at the bottom of the card. The condition of the room can be circled after "condition of room" where smearing, defecation, urination, vomit, torn scraps of paper or clothing may be described. If the patient left any reinforcers in the room, the number and types that were left are entered in the space labelled "S^R left #_____Types _____."

On the back of the card the words describing the patient's behavior when he left the ward, when he was in the patients' lounge (laboratory waiting room), when he approached the experimental room, and when he returned to the lounge from the experimental room may be circled. There is space to write the patient's reason for refusing at any stage and what the patient spontaneously said while being transported.

The results of a cursory physical examination that is conducted on each patient each day that he is studied are also entered on the back of the card. We have found this physical examination important because in a large, under-staffed state hospital a few patients develop minor physical illness that would definitely interfere with their experimental behavior. These illnesses would go unnoticed if we did not provide this examination as a precaution. The attendants on the wards do not conduct such thorough examinations on each patient each day, and we would like to be able to show that decreases in rate of response and the rhythmical changes in the behavior of some patients were not correlated with an increase

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in physical illness symptoms. Since we have been routinely examining our patients, we have sent three patients to the hospital medical wards (two with pneumonia and one with hepatitis). Additional space is provided on the back of the card for listing important observations that had not been anticipated in the body of the card.

This card has been in use since 17 August 1955 and has greatly facilitated our data collecting and processing. The descriptive items are, of course, not as objective as the counter and timer readings, but they are useful first-approximations and provide a way of measuring relationships, like the increase in defecation and urination that we have observed in some patients during experimental extinction. The next step, of course, is an IBM card, but our printed cards contain much more information than the 80 units of information stored on one IBM card, and we have not yet standardized our experimental descriptive observations to the point that we can adapt them to an IBM or Keysort system.

1.9 Development of Precise Manipulandum:

In free operant conditioning, the device that the subject manipulates defines the response that is conditioned, and the lawfulness of the data collected. It is the point of contact between the behaving subject and the automatic recording devices and can serve as a source of experimental bias and variability. Therefore, the design of this manipulandum is very important. Although most trained operant conditioners are aware of it, the problem of manipulandum precision has not been extensively treated in the literature. Ferster[10] has written the fullest description of the problems involved in manipulanda design, but his specific suggestions apply mostly to the design of pigeon manipulanda (keys). The manipulandum should be constructed so that its rate of operation will be stable under constant experimental conditions, and the limits of its rate of operation should not be set by the physical properties of the device. A manipulandum that fulfills these two requirements we will term a precise manipulandum, since it selects an experimentally useful response from the total behavior of the organism under study with a high degree of precision. Although intuitive hunches help in the design of a manipulandum, its degree of precision can only be determined by experimental test. The manipulandum should

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10. Ferster, C. B. The use of the free operant in the analysis of behavior. Psychol. Bull., 1953, 50, 263-274.

also be indestructable and easily serviced. It should also be available in standard form, so that different laboratories can collect similar responses. Early in the course of free-operant research with humans a suitable precise manipulandum should be developed.

We designed and tested the precision of several intuitively precise manipulanda for use with human subjects before we found one that was experimentally precise. It also had the advantage that, in spite of its delicate operating characteristics, it could withstand being struck by chairs, being urinated upon, and other onslaughts that deteriorated psychotics deliver to a manipulandum without changing its operating characteristics. These are important properties, because we wanted a manipulandum that could be used without modification to study the behavior of any human, from normal to extremely disturbed psychotic.

Figure 12 pictures three of the unsuitable manipulanda (1,2,3) mounted on a display board with the precise manipulandum (4) that we now use. The manipulanda labelled 1, 2, and 3 were relatively indestructible and commercially available, but they did not produce stable rates of response from humans under constant experimental conditions. All three were sometimes operated by either hand, sometimes by either foot, and on occasions with the elbows, knees, head and chin of the patients. Under constant experimental conditions, the rate of response varied depending upon which extremity the subject was using to respond with at the time. Under the same amount of motivation, a patient does not respond at the same rate with his chin as he does with the palm of his hand. The manipulandum labelled 2, had an additional defect. The device was constructed so that the black knob could be turned - thus making it more unsuitable. On intermittent schedules of reinforcement many of the subjects (both normal and psychotic) would stop pushing the button and turn it to varying positions. It appeared they were attempting to "dial in" the reinforcer as one would turn the dial on a combination lock. This "dialing" produced periods of no-responding on records that would otherwise have been even rates if the knob could not have been turned as is the case with manipulandum number 4.

Figure 13 is a schematic drawing of manipulandum 4. If it is mounted in a sloping manipulanda panel from the back (as shown in Figure 12), the patient sees only a 1-inch diameter brass knob that cannot be turned or pushed in any direction. It can be pulled out a distance of 10 mm. requiring a force of approximately 300 grams. Since the knob cannot be turned, it eliminates superstitious "dialing" responses. Since the knob must be pulled, it cannot be operated with any appendage except the left or right hand. At the forces we have used, we have noticed no differences in the rate of response of the left or right hand with any of our subjects - under our conditions the two hands seem to be experimentally equivalent.

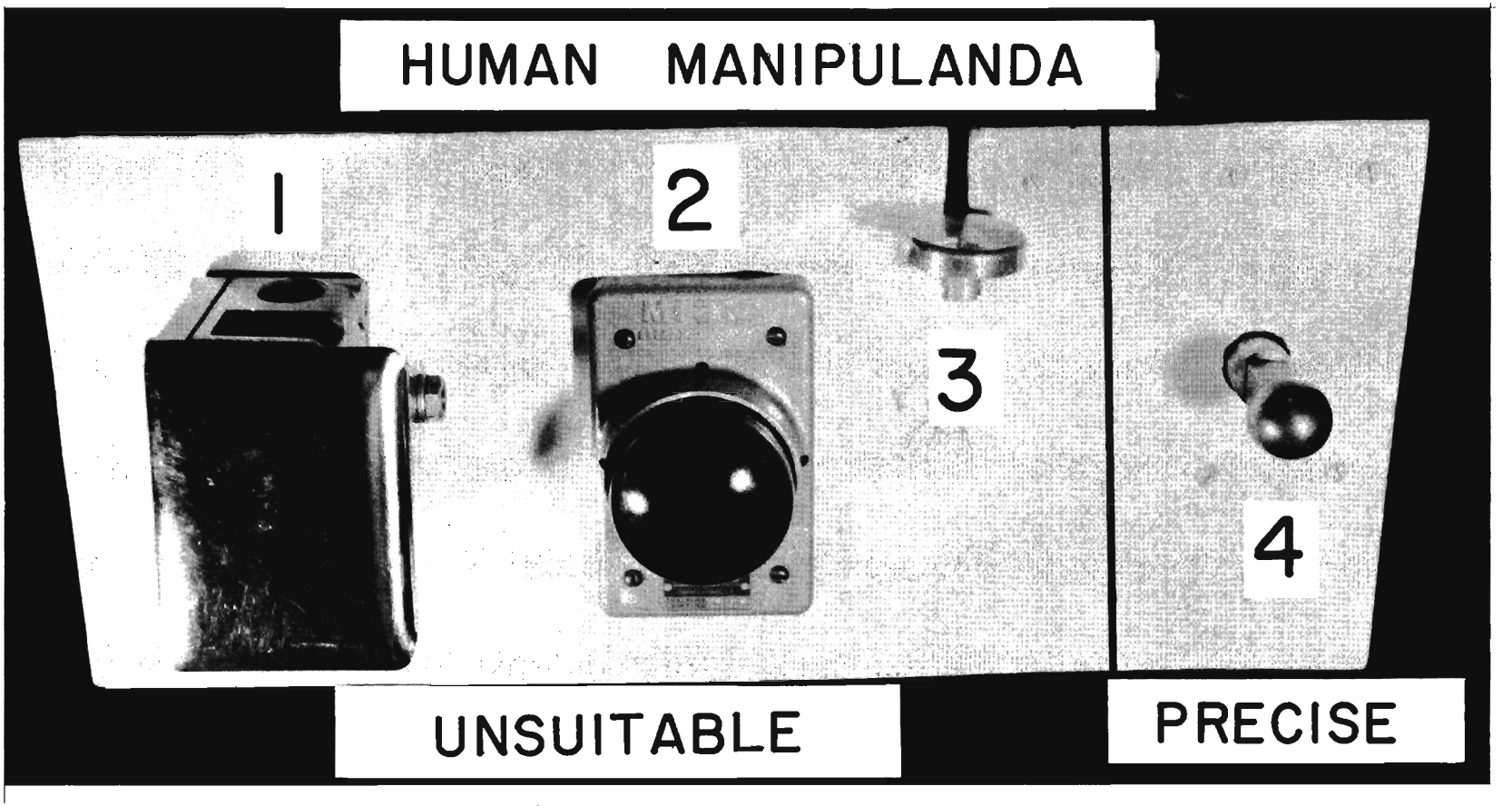

FIGURE 12

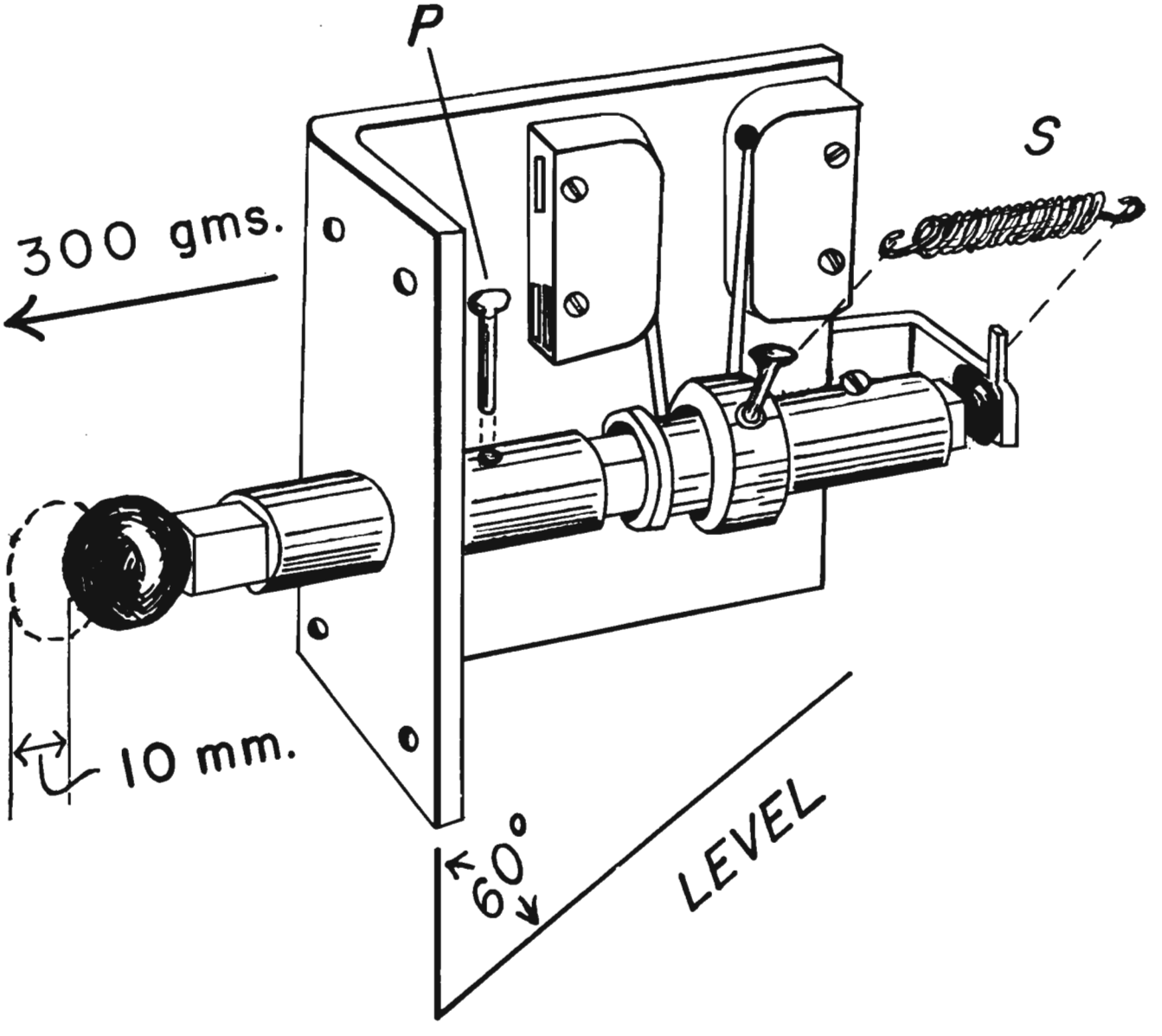

FIGURE 13

The physical upper limit of operation was determined by asking six normal subjects to pull the knob as fast as they could for one minute. A prize was offered the subject who pulled it the most times. Multiplying these numbers by 60 gave the theoretical maximum rate that the knob could be pulled by the human arm - these theoretical upper limits of operation ranged from 13,000 to 21,000 responses per hour. The highest actually recorded rate of response was 17,650 responses per hour produced by one normal adult responding on a one-minute variable-interval schedule for five-cent pieces. This highest rate was made on his 25th experimental session on this schedule, showing what could have been an acquisition of motor skill over the five-week period he had been responding. Since most of the rates of response we usually obtain vary from 0 to 10,000 responses per hour, we are working well below the upper physical limit of the manipulandum. These properties combine to make manipulandum number 4 a suitably precise device to use in recording human operant behavior.

The amount of actual work produced by subjects responding on the manipulandum can be changed by adding springs (see below). Using no spring, so that each response requires a force of 300 grams through a distance of 10 mm., a patient responding at 10,000 responses per hour expends 199 foot lbs. of work per hour. This is equal to approximately 40% of the amount of work expended by an average typist (60 words per minute) using a standard office-type typewriter. This does not seem to be an inordinate amount of work, and we have noticed very few fatigue effects until subjects respond at rates close to 10,000 responses per hour for about 5 consecutive hours. One subject was responding at rates above 3,000 responses per hour after 8 continuous hours of responding.

The indestructibility of manipulandum number 4 has been demonstrated, since we have not had to repair one since we started using them on 5 July 1955 and we have been using them 6 hours per day for a 5-day week at rates of response up to 10,000 per hour. The operating characteristics of the manipulandum were not significantly changed by such use, and we have recorded no significant difference in the amount of force needed to pull the knob when the rod is oiled or when it is dry. These observations attest to the servicability of the manipulandum.

Provisions for recording different features of each response have been provided in the design of the manipulandum. Figure 13 shows the mounting of two micro-switches which can be set to operate at any distance of travel of the manipulandum. We record "partial responses" - a movement of the manipulandum out a distance of 2 mm., and "full responses" - a movement of the manipulandum out the full distance of 10 mm. We have reinforced "full responses" only, but any combination could be reinforced on any schedule. We

have been recording approaches to within 2 inches of the knob by using a tuned oscillator which is thrown out of balance by the approach of the human hand. The brass knob of the manipulandum is used as the antenna of the oscillator.

Provisions for modifying the nature of the response in a standard fashion have also been incorporated in the manipulandum design. Different sized springs (labelled "S" in Figure 13) can be added to increase the force needed to pull the knob, thus effectively increasing the magnitude of each response. The manipulandum can be locked, preventing the occurrence of a response, by dropping a pin (labelled "P" in Figure 13) into the collar and through the manipulandum rod. This can be done either manually or automatically from behind the panel without disturbing a patient in the experimental room. The manipulanda are constructed so that they may be grouped side by side as close as 3 inches between the centers of the 1-inch diameter knobs, for use in experiments involving more than one manipulandum. An alternate locking device can be added to the bottom of such "ganged" manipulanda, so that only one at a time may be pulled out. This provision limits responses to the "either but not both" type.

We have amassed over 5,000 patient-hours of data using this manipulandum and have found nothing to indicate discontinuing its use or modifying its design. It is now commercially available[11] and is being used by five other laboratories investigating human operant behavior. This should provide a welcome uniformity in our respective data.

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11. From Ralph Gerbrands, Scientific Instruments, 96 Ronald Road, Arlington, Mass. A complete manipulandum panel, including one or more manipulanda, stimulus panels, and a magazine tray and chute can be purchased from Robert C. Dalrymple, 30 Wyman Road, Lexington, Mass.

2.0 WORK IN PROGRESS

2.1 Teaching Functions:

The training of new personnel and the communication of basic research methods to interested workers in allied fields are among the functions of Government-sponsored research. The following teaching functions have been performed during the period covered by this report:

a) Supervision of Individual Research:

Dr. Martha Mednick, a Public Health Service Postdoctoral Research Fellow, has been using the laboratory facilities to investigate various aspects of conditioned reinforcement (conditioned gratification) with psychotic children. Drs. Solomon and Skinner have sponsored this fellowship.

b) University Field Trips:

Invitations to visit the laboratory and hospital have been extended to the psychology departments of neighboring colleges and universities. The following groups have visited the laboratory:

Brown University, survey course in psychology - 71 students
Harvard University natural science course - 90 students
M. I. T. psychology course - 35 students.

c) Lectures:

Descriptions of the method and results of our research have been presented to the following groups (chronological order):

Colloquium, Boston University
Colloquium, Dartmouth College
Seminar, Metropolitan State Hospital
Colloquium, University of Massachusetts
Regional Research Conf., Amer. Psychiatric Assoc.
Clinical Psychology Section, Walter Reed Hospital, Washington, D. C.
Student Nurses, Metropolitan State Hospital
Meeting, American Psychological Association
Research Department, Upjohn & Co., Kalamazoo, Michigan
Seminar, West Haven V. A. Hospital, West Haven, Conn.

d) Professional Visitors:

One hundred and three interested scientific workers have visited our laboratory since 1 September 1955. They were conducted through the hospital, were shown our apparatus and equipment, and were shown the data in which they were most interested.

2.2 Intensive Analysis of Individual Patients:

An important phase of our research is the discovery of deviations in the behavior of our patients and the attempt to overcome these deviant behaviors with intensive training. Because the behavior of many patients is so slowly modified, this analysis demands long-term, intensive investigations (by psychological standards) with a few patients. A summary of the long-term investigations we are now conducting with eight patients follows:

Patient Number	Number of Experimental Sessions	Main Experimental Interest
1	350	Rate increase and cycles (Candy 1' VI)
36	150	" " " "
7	250	Extinction after variable-interval reinforcement
23	300	" " " " "
32	250	" " " " "
22	350	Fixed-ratio 5 (pauses and rate increase)
31	250	" " " " " "
35	250	Fixed-ratio 40 " " " "

An estimate of the calendar time taken by these studies can be made by observing the number of experimental sessions and realizing that we collect about 250 sessions per year. Ratings of the ward behavior (using the Lucero-Meyer Behavior Rating Scale) are being collected approximately every week for correlation with the changes observed in the experimental behavior of the above patients. Some of the peculiar effects we are currently investigating are described following in detail.

The rate of response of our first patient (P-1) steadily increased for over 250 daily sessions on one-minute variable-interval reinforcement with candy. Concurrently there appeared to be an increase in the patient's adjustment to the hospital. The rate of response decreased sharply during extinction and his behavior on the wards deteriorated. He is currently not being studied in our experimental rooms while we rate his ward behavior periodically to see if there are any "spontaneous" changes not related to the experimental behavior. We later plan to reinforce the patient again with candy in an attempt to reproduce the previously observed increase in rate.

Another patient (P-36) appears to be going through a similar long-term rate increase under one-minute variable-interval reinforcement with candy. This rate increase was predicted after observing a steady increase during the first 20 hours of conditioning. We have recorded about 100 sessions so far and are also making periodic ward behavior ratings. Perhaps the results obtained with P-1 can be reproduced with P-36.

Another patient (P-32) also steadily increased his rate of response on one-minute variable-interval reinforcement with candy during the first 20 sessions. We predicted a steady rate increase which was verified during the first 50 sessions. The rate was reduced during the next 90 sessions by extinction. The rate was again increased for the next 50 sessions by one-minute variable-interval candy reinforcement. It was again reduced during the next 100 sessions by extinction. The plan is now to reinforce the patient for approximately 250 sessions to see if the rate will continue to increase as did the rate of P-1 and P-36. If this occurs, we will have shown that the very high rates produced by the long-term conditioning of patients of this type are due to a long continuous previous history of reinforcement, rather than just a long previous history of experimentation within the room. Keeping the rate at low values by alternating reinforcement and extinction with P-32 for the first 300 sessions has shown that just a long number of hours of previous experimentation is not ample to produce high rates of response during reinforcement.

Another patient (P-23) has responded for over 230 hours (one hour per day) in extinction (no reinforcement) without any decrease in his rate of response. We are currently attempting to determine whether this continued responding is due to a general inability to extinguish, or whether it is due to some source of hidden reinforcement in our experimental situation. This is a very important behavior anomaly to investigate because 1) no cases of the failure to extinguish following positive reinforcement have been reported in the psychological literature, 2) if this patient truly can modify his behavior as a result of the presentation of reinforcers (reinforcement), but does not modify his behavior when the reinforcers

are withheld (extinction), then one of the most general theories of experimental psychology will be embarrassed - the notion that acquisition and extinction are actually the same process and are accomplished by the same mechanism. Acquisition is learning to respond, and extinction is simply learning not to respond, and 3) this failure to extinguish might typify a clear-cut behavioral anomaly. Such a functional deficit is the kind of behavioral symptom we are seeking in our analysis of psychosis.

To date we have shown that this high rate of response can be maintained at rates above 6,000 responses per hour for years without reinforcement. Other patients conditioned with the same schedule and reinforcing agent stop responding very soon after they are no longer reinforced. We have also shown that this high extinction rate does not generalize to two other similar experimental rooms. This means that the patient is not responding at a high rate "just to please us" or because "he thinks he has to," because he only responds at a high rate in the room where he was once reinforced. We intend to slow down this high extinction rate by reinforcing responses made after long pauses (differential reinforcement of low rates - DRL). If this is possible, it will demonstrate the important point that even though the patient's rate of response does not drop during extinction, his responding is still controlled by the presentation of positive reinforcers. Then it will be clear that his "reinforcer" is working but that his "extinguisher" is broken.

One patient (P-35) has shown long-term (60 to 70 day) rhythms in his rate of response, the percentage of long pauses after reinforcement, and his ward behavior ratings while he was responding on a fixed-ratio schedule for candy reinforcement. It might be possible to correlate these three measures at the different points of the patient's symptomatic cycles.

2.3 Effects of Chlorpromazine:

To date 6 patients have been placed on chlorpromazine medication while we were studying their experimental behavior. Since the drug is supposed to reduce the severity of psychotic symptoms, it might permit patients to respond at higher rates by reducing the amount of time they spend engaging in their psychotic behavior during each experimental session. This seems to be true with some patients, but it does not seem to be the case with others. We have not yet made enough observations on a large enough sample of patients responding for the same reinforcer on the same schedule to enable us to evaluate the differences in response to chlorpromazine between

different patients. However, the evidence to date suggests that there are great individual differences in response to the drug. Whether some of these patients are placebo-reactors cannot be answered until we run the necessary controls with other medications. A few examples of the results we have to date are described below.

P-42 is a 43-year-old male chronic psychotic who has been hospitalized continuously for 11 years. He was diagnosed dementia praecox, catatonic type, at admission and received a bilateral, prefontal lobotomy 7 years ago. He lives on a locked ward, and his personal habits are about average for a mental patient. He hallucinates almost continuously and is abusive to and swears at almost everyone that passes by. His ward behavior was rated 2.5 to 2.7 on a scale from 1.0 (regressed) to 5.0 (normal) using the Lucero-Meyer behavior scale, and he responded at a median rate of 20 responses per hour on one-minute variable-interval candy reinforcement for 14 experimental sessions before he was placed on chlorpromazine medication.

He was given 150 mg. of chlorpromazine daily (50 mg. tid) for the next 58 experimental sessions. During this period of time his rate of response increased from 20 responses per hour to a median of 170 responses per hour for the last ten sessions, with no significant change in his ward behavior ratings. He was then placed on 300 mg. per day for 8 sessions, and 600 mg. per day for 6 sessions, followed by 900 mg. per day for 40 sessions. His rate of response had fallen to a median of 75 responses per hour during the last 20 sessions on 900 mg. per day of chlorpromazine (300 mg. tid). His ward behavior ratings did not significantly change, ranging from 2.3 to 2.9 during the entire course of medication. The patient was less abusive to passers-by, talked more softly and was less active than prior to medication, but he was no better adjusted to the hospital environment. Although he still responds at a moderate rate for the candy reinforcers, his rate was much higher under 150 mg. per day medication. We plan to terminate medication soon, to see what the effect will be on his experimental behavior.

P-44 is a 53-year-old male chronic psychotic who has been hospitalized continuously for the last 34 years. He left the second grade at the age of 14 and was diagnosed catatonic on admission. He lives on the regressed ward and often urinates or defecates in his trousers and bedding. He characteristically says nothing, will not answer when spoken to, and spends most of his day standing around the ward in a stooped position. Several times he has been struck in the face by disturbed patients and he did not even move away or flinch from the blow. His ward behavior ratings ranged from 1.4 to 1.9 on the Lucero-Meyer scale and he responded at a median rate of zero for candy and female nude pictures presented on

the one-minute variable-interval schedule for 13 experimental sessions prior to medication.

He was placed on 150 mg. per day (50 mg. tid) of chlorpromazine for 30 sessions, and his rate of response for candy and five-cent pieces was increased to a median of 15 responses per hour for the last 10 sessions with a range of 0 to 355 responses per hour. He was then placed on 300 mg. per day for 31 sessions, and his rate of response increased to a median value of 165 with a range from 3 to 604 for the last 20 sessions. The ratings of his ward behavior (ranging from 1.5 to 2.0) were not significantly changed during this period. When taken off medication, his rate of response abruptly fell to 0 responses per hour. It appears that chlorpromazine, in 150 to 300 mg. per day dosages, significantly increased the rate of response of this very regressed patient, but did not alter his ward behavior as measured by the behavior ratings.

P-46 is a 26-year-old male chronic psychotic idiot who has been hospitalized continuously for 22 years. He lives on the disturbed ward and is one of the two most disturbed and regressed patients in the hospital population of over 1800. He does not keep his clothes on, eats and defecates only in his seclusion room, and does not talk, making only animal noises. Two or three times a day he runs naked about the ward, yelling and leaping off the walls while he strikes the top of his head violently with the palm of his hand. At times he grabs food from the mouths or hands of other patients, frightening them very much. It is this behavior that has confined him to the disturbed ward. By reinforcing him for walking beside the experimenter, we gradually conditioned him to leave his ward and enter one of the experimental rooms. On a fixed-ratio twenty schedule of reinforcement with candy, his rate of response gradually increased over a period of 40 experimental sessions to a median of 280 responses per hour for the last 10 sessions. His ward behavior ratings during this period ranged from 1.0 to 1.9. During the next 4 sessions he was given 150 mg. per day of chlorpromazine (50 mg. tid). The dosage was increased to 400 mg. per day for the next 6 sessions, and to 600 mg. per day for the following 4 sessions. During these 10 sessions his rate of response increased to 790 responses per hour. He was then given 800 mg. per day (200 mg. tid) for 50 sessions which produced no significant change in his rate of response. The median rate for the last 10 of these 50 sessions was 660 responses per hour with a range from 490 to 1,365 responses per hour. During this period there was no significant change in his ward behavior ratings, which ranged from 1.5 to 1.9. The only noticeable changes in his ward behavior were that he ran about and struck his head less often and made less noise. He also seemed to walk slower and did not follow the experimenter to the laboratory as readily as before the medication. It is important to note that the patient had developed pauses following reinforcement on the

fixed-ratio schedule. This pausing after reinforcement - one characteristic effect of fixed-ratio schedules of reinforcement (see section 1.3) - was not noticeably changed by the chlorpromazine administration.

He had also been responding for female nude pictures on a fixed-ratio 20 schedule in a second experimental room each day at a median rate of 660 responses per hour, ranging from 250 to 2,269 responses per hour prior to the chlorpromazine administration. This rate fell to a median value of 355 responses per hour for the last ten sessions, and he refused to enter the room where he was reinforced with female nude pictures on the 9th session after the dosage had been increased to 800 mg. per day. This shows that the chlorpromazine markedly decreased his rate of response for female nude pictures while it increased, or at least left impaired, his rate of response for candy reinforcers, suggesting that the drug might selectively reduce sexual motivation in some patients. At the same time there was no measurable increase in his ward behavior ratings, although the intensity of his psychotic symptoms appeared to be decreased.

P-2 is a 36-year-old chronic psychotic who has been hosptialized continuously for 19 years. He was diagnosed schizophrenic reaction, catatonic type, and received an I.Q. of 89 at admission. He is currently untestable by the usual clinical tests. He walks about constantly with his head down and a scowl on his face. Sometimes he mumbles and sings and occasionally he will attack another patient yelling, "Margaret told me to do it." He is periodically placed on the disturbed ward for his frequent unprovoked attacks on other patients. When spoken to he answers in monosyllables which are sometimes irrelevant.

For the first 80 experimental sessions he responded at rates of response ranging from 0 to 265 responses per hour on a one-minute variable-interval schedule of reinforcement with candy. The schedule was changed to fixed-ratio 20 for the next 50 sessions and his rate of response fell to 0 responses per hour, showing that he could not respond on a ratio schedule. When the schedule was changed back to one-minute variable-interval, his rate of response increased to a median of 25 responses per hour during the first 10 sessions. At this time he was given 400 mg. per day of chlorpromazine for 20 experimental sessions. His rate of response was not significantly changed during this time. He was then given 150 mg. per day for 50 experimental sessions with no appreciable change in his rate of response.

He then spent 7 months on the wards without experimental observation and was brought back to the laboratory to respond to feed the kitten, for five-cent pieces, for male and female nude

pictures, and to turn off a 2,000 cycle tone in unsuccessful attempts to increase his rate of response by the use of different reinforcers. He spent another 4 months out of the experiment and was brought back to respond for candy on the one-minute variable-interval schedule for 13 sessions at which time he was given 1.5 mg. per day of serpasil in an attempt to increase his rate of response. After 7 experimental sessions, the dosage of serpasil was increased to 3 mg. per day (1 mg. tid). There was no significant increase in his rate of response for candy reinforcement or to turn off the 2,000 cycle tone during 80 sessions under serpasil medication.

During all of these experimental manipulations there were no significant changes in the ratings of P-2's ward behavior, which ranged from 1.4 to 2.3.

We have been unable to increase this patient's rate of response in over 400 experimental sessions using two different schedules of reinforcement, six different reinforcing agents (one aversive), and two drugs (chlorpromazine and serpasil). Six other patients responded at very low rates and have shown this same resistance to long-term differential reinforcement and pharmacological agents in attempts to increase their rates of response.

To summarize the effects of chlorpromazine, it is clear that the same dosage significantly increased the rate of response of some patients and significantly decreased the rate of response of others. Similar results showing different experimental effects of drugs on different individuals have been previously reported using benzedrine with dogs[12] and dexedrine with psychotic children[13]. Individually different drug effects have also been reported on the clinically appraised activity level of children[14]. Because of these

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12. Lindsley, O. R. The effect of amphetamine sulfate on the operant behavior of the dog in Final Project Report, AEC Contract AT(30-1)1201, 1953, 185-198. Available from Microcard Foundation, Madison, Wisconsin, #NYO-4548.

13. Lindsley, O. R. Status Report III, ONR Contract N5-ori-07662, Behavior Research Laboratory, Harvard Medical School, Waltham, Mass., December 1954, p. 4.

14. Bradley, C. Benzedrine and Dexedrine in the treatment of children's behavior disorders. Pediatrics, 1950, 5, 23-47.

high individual differences in the behavioral response to many drugs, investigations of the effects of drugs on behavior should be designed to permit analysis of the data with respect to each individual. Averaging the data in group-research designs would in many cases occlude significant individual responses to the medication. The chlorpromazine effects we have observed are probably related to the dosage, which should probably be given different patients in different amounts in order to produce similar behavioral effects. Further research done in a more systematic fashion will permit more detailed conclusions concerning these effects. In continuing this research, we will study patients with more complex experimental behavior (e.g., fixed-interval schedule of reinforcement, discrimination, differentiation, conditioned suppression). It would be very enlightening to investigate the effects of the drugs on the experimental behavior of normal subjects.

2.4 Duration of Experimental Session:

We have long desired to investigate the optimal length of the experimental session. In most cases we have used sessions of one hour's duration because: 1) these seemed long enough to provide an adequate sample of experimental behavior, 2) most patients did not ask to leave the rooms during this period, 3) one-hour timers are readily available, and 4) the hospital staff did not object to sessions of this length. Because the analysis of problems like the most useful reinforcer to use in conditioning chronic psychotics (see sections 1.4 and 1.5) were more pressing, we have not made a systematic investigation of the optimal length of the experimental session. We still do not know what length experimental session will produce the most rapid behavior modification with chronic psychotics in a hospital setting. It is quite possible that two, three, or four-hour sessions might be more efficient than the one-hour session we have used, but the optimal duration can only be determined experimentally.

Over the past three years we have gradually increased the duration of time that some of the patients spend in the experimental rooms each day. Three factors limit the length of the experimental session. These are: 1) some patients withdraw from the rooms when the sessions become very long. If they can speak they often say they are tired, bored, scared, or simply "let me out." 2) The rate of response of some patients gradually decreases when they have been in a room for a matter of hours. This suggests satiation from the acquisition of too many reinforcers, "boredom" from the constant experimental environment, or fatigue from pulling the knob. And 3) the hospital staff objects to the long sessions because they have other demands on the patients' time.

The number of withdrawals and rate decreases can probably be reduced by increasing the complexity of the experimental problem (decreasing "boredom") and decreasing the frequency of reinforcement (decreasing satiation). Increasing the amount of deprivation is currently unfeasible with our patients, and selecting a stronger reinforcer has in most cases been unsuccessful (see section 1.4). Since the manipulandum has been operated at rates above 10,000 responses per hour for many hours by some patients without fatigue, and since the amount of work involved is approximately one third that expended by an average typist (see section 1.9), it doesn't seem probable that fatigue is an important cause of the decreased rate of responding observed towards the end of long sessions. The objections of the hospital staff occur less often the longer we are members of the hospital community, so this limitation to long sessions should become less important in the future.

Many patients have responded for one hour in each of three different rooms each day for many days without withdrawing or showing any decrease in rate of response compared with the days they responded in only one room for one hour. In an experiment involving the formation of a complex discrimination, 20 patients have responded in 3 daily sessions of four continuous hours each. Several of the patients withdrew for toilet visits, but immediately returned to the rooms when they were through. These toilet visits (which do not occur very often) do not seem to interrupt the experimental behavior. (In some cases "fixed-ratio runs" have not been changed in duration by 15-minute toilet interruptions.) Six of these 20 patients refused to re-enter the room (a total of 10 withdrawals) after periods of responding from 2 to 3 1/2 hours. This shows that, with most patients, sessions of four continuous hours duration are possible.

One patient (P-7) responded for over 8 continuous hours on a one-minute variable-interval schedule for candy without leaving his chair or asking to leave the room. We do not expect such long sessions from most patients, but 3 or 4-hour sessions seem very likely, once the hospital can arrange to release patients for such long periods of time.

3.0 ALTERATION OF PREVIOUS PLANS

3.1 Effects of Insulin and Electro-Shock:

Since the patients undergoing insulin and electro-shock therapy are usually acute patients who have been in the hospital only a short time, it is impossible to record a very long base-line of behavior before they undergo treatment. Also, if the patients recover, they are discharged from the hospital almost immediately, making post-treatment control sessions almost impossible to obtain. Therefore, we have indefinitely postponed these investigations until arrangements can be made which will permit adequate pre- and post-treatment control sessions.

3.2 Effects of Lysergic Acid on Normal Subjects:

In Status Report IV we reported the results of some exploratory experiments with two normal subjects who received lysergic acid (LSD 25). Since 60 gamma LSD produced changes in the operant behavior of these two subjects similar to the behavior obtained from many of our chronic psychotics, we had planned to follow up these observations with a more systematic study. To show psychoso-mimetic drugs produce behavior deviations in normal subjects that are similar to the peculiarities we have recorded in the behavior of chronic psychotics would make an important addition to our analysis of psychosis.

The exploratory experiments were done in collaboration with Drs. Robert W. Hyde and Richard H. York of the Boston Psychopathic Hospital. These investigators have recently moved to Butler Hospital in Providence, Rhode Island, making further collaboration more difficult at the present time. Therefore these investigations will be indefinitely postponed until other arrangements can be made.

3.3 Use of Food as a Reinforcer:

Since one of the strongest reinforcers used with lower organisms has been substantial food delivered to food-deprived animals (80% ad-lib body weight plus 24 hrs. deprivation) we have long planned to use food and hunger schedules with the extremely deteriorated patients who have made very few responses for the other reinforcers. Exploratory study with a few of these patients has shown

that food used with only 5 or 6 hours of food deprivation had little effect in increasing their rates of response. Until more substantial hunger schedules can be arranged, the systematic investigation of the use of food as a reinforcer will be indefinitely postponed.

4.0 PLANS FOR FUTURE WORK

4.1 Observations on New Patients:

We plan to continue slowly to add new patients to the population we have studied, in order to get larger groups of patients with similar behavior anomalies. Larger groups will permit a systematic investigation of these anomalies and we can begin to define syndromes of behavior anomalies. There is some evidence to suggest that some of the behavior anomalies we have recorded might occur together. The demonstration of this tendency demands at least a few patients in each syndrome. Since there is no way to predict before our experimental observations what patients will have which behavior anomalies, we must rely upon routine screening to increase the number of patients in each category.

4.2 Effects of Ritalin, Serpasil, and Dexedrine:

With the patients who have responded at consistently low rates for all the reinforcers we have used to date, we plan to attempt to increase their rates of response by the administration of large clinical dosages of ritalin, serpasil and dexedrine. Since these drugs are thought to be excitatory, it is possible that they might increase the rates of response of the very deteriorated patients. However, it is also possible that the drugs might increase the frequency and/or intensity of the patients' psychotic symptoms resulting in an even greater conflict with the knob-pulling and a consequent reduction in their operant rate of response. Only experimentation will give us the answer, and here, again, individual differences in the responses of the different patients to the drugs are anticipated.

4.3 Exploration of Useful Aversive Stimuli:

Much of the experimentation done on lower animals strongly suggests that different patterns of aversive stimulation (avoidance, escape, punishment, approach-avoidance conflict, etc.) are involved in the development of aberrant forms of behavior (experimental neurosis); also many clinical theories suggest that the etiology of neurosis and psychosis is closely allied to aversive and traumatic situations in the individual's previous history. For these two reasons, aversive stimulation should be investigated early in the experimental analysis of psychosis.

Such investigations demand a practical aversive stimulus for use with psychotic patients. The stimulus should in no way produce physical damage to the patients and should be accurately controlled in intensity from non-aversive to strongly-aversive values. Most of the aversive stimuli used with lower organisms are impractical for use with human patients, because the patients must be left free to leave the experimental rooms at any time, and they cannot, of course, be stripped and placed on shock-grids as can most of the lower organisms.

We have had some success in using a moderately intense (90 db above the human threshold of hearing) pure tone which becomes quite aversive after it has been on continuously for a few minutes. But many patients do not respond to turn this tone off or to delay its onset. Therefore, the tone acted as an aversive stimulus to normal subjects and some of the patients, but not for all of the patients. The tone has another disadvantage. It is most aversive at high frequencies, but these high frequencies go through our cinder-block walls with little attenuation. So that, when the tone is on, we have been presenting mildly aversive stimuli to much of the hospital population. An ideal aversive stimulus would be contained within the experimental room it is used.

Lately we have been delivering mild shocks across the brass manipulandum knob and to ground. The shocks are generated by a model-T Ford transmission coil and contain a lot of high frequency components, so that the capacity between the patient and ground (through his shoes) is enough to deliver a mild shock to the patient's hand when he touches or pulls the knob. This stimulus has limited experimental applications, because the patient can avoid it by not touching the knob. Extremes of temperature are not practical because the patients might catch cold. We plan to try using air blasts, and vibration, in further attempts at a practical aversive stimulus for use with chronic patients.

4.4 Analysis of Refusals and Withdrawals:

We have been systematically recording the number of refusals to leave the wards, the refusals to enter the experimental rooms, and the withdrawals from the experimental rooms before the completion of the experimental sessions. An analysis of these refusals and withdrawals will permit the inter-correlation of these measures to see if they tend to occur together. It is possible that some patients differ markedly with respect to these tendencies. (In Status Report III, section 1.2, we reported that children diagnosed "autistic" had to be conditioned to stay alone in the rooms. The other psychotic children did not withdraw from the rooms.) It should also be possible to demonstrate that these measures increase in fre-

quency under certain experimental conditions (i.e., extinction and operant level).

4.5 Differential Reinforcement of Low Rates:

With patients who respond at high rates and with patients who will not extinguish (i.e., P-23), we will reinforce those responses that occur after long pauses in an effort to decrease their rate of responding. If the rate of response is thus decreased, it will be clear that the high rates of response are under the control of the reinforcing stimuli and not just "manic tendencies" or "high activity levels." There is a possibility that these reinforced long pauses will tend to be filled with psychotic manifestations by the patients. This would show a full control of psychotic incidents by differential reinforcement in some patients, because the reinforcement of short inter-response times has been shown to decrease the amount of psychotic activity during the experimental sessions, and the successful reinforcement of long inter-response times would then show that the amount of psychotic activity could be increased. It would also argue strongly for "total push programs" and against the forced inactivity in the many under-staffed and under-supported large State Hospitals.