

ACQUISITION OF OPERANT DIFFERENTIATION AND DISCRIMINATION IN INSTITUTIONALIZED RETARDED CHILDREN*

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A device for simultaneous measurement of free-operant response differentiation and stimulus discrimination demonstrated specific deficits in the two functionally independent processes. A constant apparatus program revealed reliable individual differences in speed, sequence and efficiency of acquisition and in performance stability. Neither age, psychometric scores, verbal facility, nor duration of institutionalization accurately predicted individual performance. Continuum extremes were related to school progress.

THERE HAVE BEEN NO reports of laboratory investigations which systematically follow the initial course of discrimination learning in individual mentally retarded children. Early acquisition or "training" data are most commonly used as a means of empirically determining various criteria for inclusion of subjects in later group experiments. Examples are found in the well known comparative studies of learning in normals and retardates by Zeaman and House and their associates.^{15, 16} With the more recent advent of free-operant investigations in this field,^{6, 7, 14} "training" periods have

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served to shape up behavior, to demonstrate schedule effects and to develop techniques for rapid production of stable baseline performances. In no instance has the focus been on individual patterns of acquisition shown in an experimental environment which remains constant until stable performance is reached.

The research reported here concerns the adequacy of a laboratory device for sensitively measuring individual behavior patterns of institutionalized mentally retarded children during acquisition of free-operant response differentiation and stimulus discrimination. Information on the widest range of retarded behavior can be obtained only if the instrument is capable of continuous, reliable operation throughout the course of behaviorally disturbed episodes for which many children have been institutionalized. In addition, the device should be free from culturally determined effects, personal and theoretical bias, and language comprehension requirements. To be maximally useful in research on behavior pathology, such a device should be sensitive to a variety of behavior patterns and should effectively distinguish degrees and types of functionally defined behavior deficits along a continuum from normal, efficient responding to severely defective behavior.

Retarded individuals are so labeled because of limitations in the scope or in

the rate of development of their ability to acquire new response repertoires. A sensitive laboratory measure should provide ample opportunity for characteristic acquisition defects to emerge. Examples of selected defective patterns in individual children were described earlier.² An overview of acquisition patterns within the total subject group is presented here.

METHOD

Experimental Enclosure

Since the *child's* behavior changes are the focus of interest, potential unknown sources of distraction and recording errors are eliminated by use of an automatically controlled environment. A small cinderblock chamber, with masking noise and a hidden periscopic observation system¹ contains a conditioning panel which presents two lights, a plunger manipulandum beneath each light, and a reinforcement delivery tray inset to the right of the plungers (FIGURE 1).*

Experimental Design

Most discrimination tasks require the subject to respond to the "correct" stimulus *with the "correct" response*. Differentiation of responses is a prerequisite assumed to be within the child's repertory. Should the subject appear unable to tell the stimuli apart, he may be

* The discrimination panel was designed by Ogden R. Lindsley, Ph.D., Professor of Education and Research Director, Children's Rehabilitation Unit, University of Kansas Medical Center, formerly Director of the Harvard Medical School Behavior Research Laboratory at Metropolitan State Hospital. Dr. Lindsley's generosity in providing experimental space, equipment, and appropriately scheduled encouragement enabled this investigator to learn from the data the value of unhurried, well controlled observation of natural phenomena.

The conditioning panel is commercially available from Behavior Instruments Company, 20 Fletcher Avenue, Lexington, Massachusetts 02173.

The periscope is commercially available from the Shintron Company, 1 Main Street, Cambridge, Massachusetts 02142.

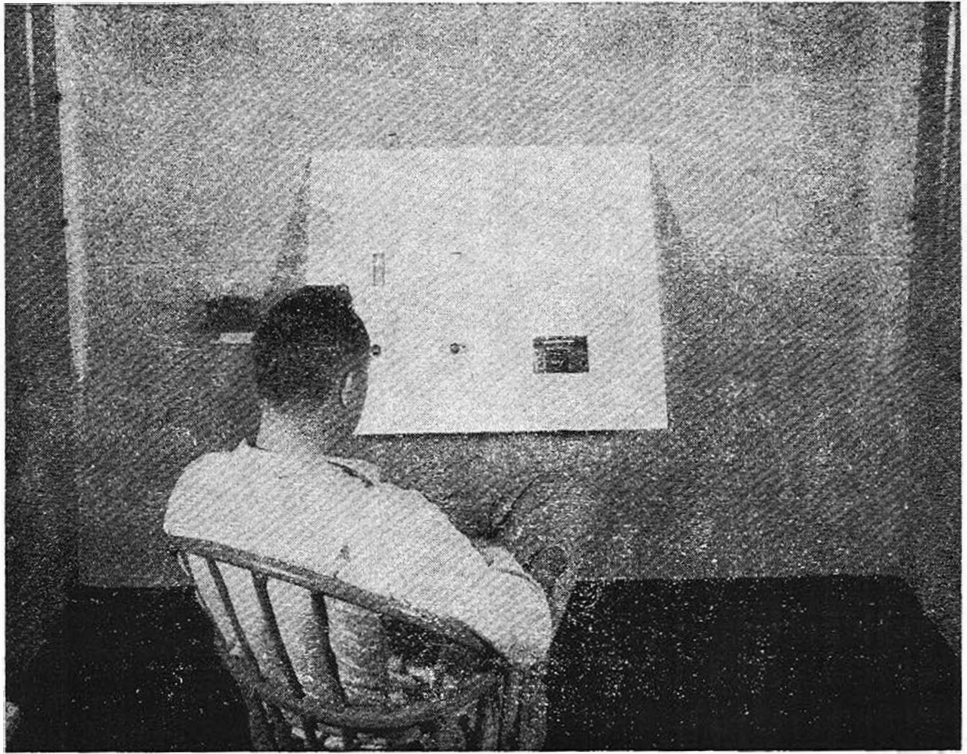


FIGURE 1. Device for simultaneous measurement of differentiation and discrimination.

considered to have defective discrimination when his more basic problem, unmeasured by conventional designs, may be a current inability to tell responses apart. Defects in either or both of these behavior processes may underlie some of the "learning" problems of retarded children.

The behavior of some retarded children is characterized by marked variability, both from day to day and from moment to moment.² For this reason, a device which *separately measures both* response differentiation and stimulus discrimination in a single subject during a single session should disclose variations and interactions which would be

obscured by the subject's behavior variability if the processes were sequentially measured in successive sessions.

A program for simultaneous measurement of response differentiation and stimulus discrimination^{2, 9, 11, 12} presents the child with two stimulus configurations: left light on (C1), right light on (C2), alternating at one-minute intervals. The two plungers (M1 and M2) may be pulled separately or simultaneously at any time. With two stimulus configurations and two available responses, four reflexes may be measured.

Reinforcement—payoff—was programmed for only one of these reflexes.

Pulling the left manipulandum with the left light on (C1M1) was reinforced on a fixed-ratio 10 schedule; i.e., every 10th occurrence of C1M1 would produce a penny or a piece of candy. (There was a random mixture of one penny to every six candies.) The other reflexes, C1M2 (right manipulandum responding with left light on), C2M1 (left manipulandum responding with right light on), and C2M2 (right manipulandum responding with right light on), were programmed on extinction; i.e., they never produced candies or pennies. Since the purpose was to reveal rather than to eliminate deviant or unusual response patterns, no reflex attenuation procedures were used in this phase of the research. Reflexes were functionally recorded by separate tallying and cumulative recording of each plunger operation with respect to the light configuration under which it occurred.*

By programming payoff for only one reflex, we are able to separate the process of response differentiation (telling the plungers apart) from the process of stimulus discrimination (telling the lights apart) and to describe these processes functionally in terms of a subject's behavior patterns. (See diagram of functional description.²) The presence of both response differentiation and stimulus discrimination is indicated by a high C1M1 rate, with little or no emission of the reflexes which do not pay off. Absence of response differentiation is shown by the child who continues to

pull both plungers, but the same child may demonstrate discrimination by pulling them only when the left light (C1) is on. If he pulls only the left plunger irrespective of which light is on, he has formed a response differentiation but is not discriminating the lights. If he has formed the differentiation and the discrimination but continues to pull the right plunger when the right light is on, he is limited by excessive reflex generalization.

Subjects

Initial subject selection was guided by the related strategies of individual differentiation and functional calibration. To be maximally useful in defining patterns of deficit, our device should be capable of distinguishing among individuals within a recognized deficit population considered to be relatively homogeneous by other less sensitive criteria. In selecting an institutionalized population, we sought maximum deficit as defined by society's consignment to a special, segregated environment. The uniformity of the immediate surroundings for most residents, the absence of multiple-agent, intensive treatment and training, and the practice of long-term institutional residence provided some approximation of environmental control not found in the community.

To determine if our method could pick up behavioral differences within a group of institutionalized retarded chil-

* Counters tallied the occurrences of each response under each light condition (i.e., C1M1, C1M2, C2M1, C2M2). The moment-to-moment rates of each of these reflexes were automatically graphed by four cumulative response recorders. The cumulative response recorder feeds paper horizontally at a constant speed while each plunger-operation moves the recording pen one step in a vertical direction. After 450 responses have been recorded, the pen automatically resets to the base and is ready to step up with the next response. Horizontal lines in the graphs are periods when no responses occurred.

dren, we selected 25 residents representing a wide range of medical diagnoses, ages (7 to 20 years), psychometric scores (IQ 33 to 81, MA 2-11 to 10-6), educational levels, verbal skills, institutional ward placements, and durations of institutionalization (2 weeks to 11 years). Included in the group were two sets of siblings, each representing a subgroup with remarkable homogeneity of medical, social, behavioral, educational and demographic features. Also included were a number of children on anticonvulsant medication.* Two noninstitutionalized, non-retarded children, ages 4 and 6, were included to define the normal end of the behavioral continuum.

Procedure

Each child had individual, one-hour, weekly sessions. At this stage of the research, since we were not concerned with "shaping" nor with the effects of instructions or demonstrations, a child's introduction to the experiment was minimal. He was shown the two plungers and the candy-delivery aperture, and he was told that he could learn how to work the machine to get candies and pennies which he could keep. He could start when the lights went on and he could continue until the machine shut off. No further explanation was given, the experimenter departed, and the experimental room was locked until the hour was up. If by the end of 10 minutes a child had not operated one of the plungers, he was reminded that he would have to "work" on the machine for his candies.†

Each child continued his weekly sessions under the previously described program of differential reinforcement, until his performance had stabilized over a number of sessions. No experimental changes were introduced against the moving baselines developing during acquisition. The number of experimental sessions for each child was determined by his session-to-session reflex stability irrespective of the nature or amount of acquisition that had occurred.

EXPLORATORY RESULTS

Case Illustration

To facilitate interpretation of the summarized data, we present the cumulative records of the first five experimental sessions (ES 1-5) of one retarded child (FIGURE 2). These records illustrate the recording system; the functional description of both response differentiation and stimulus discrimination; and the gradual, regular development of maximally efficient performance. Throughout his first experimental session (ES 1) this boy pulled the plungers randomly during both light conditions; thereby he showed that he neither differentiated the plungers nor discriminated the regularly alternating light configurations. During sessions 2 and 3 his reinforced reflex (C1M1) rate increased while his C1M2 rate successively decreased to almost zero; thus, he was telling the plungers apart. The zero C1M2 rate, concurrent with the high reinforced reflex rate maintained in sessions 4 and 5 shows the stability of his response differentiation. Although

* A more detailed description of these children appears in Barrett & Lindsley, 1962.²

† In two cases with questionable motor control, the child's hand was placed on one of the manipulanda and he was shown how to pull it while the apparatus was inoperative.

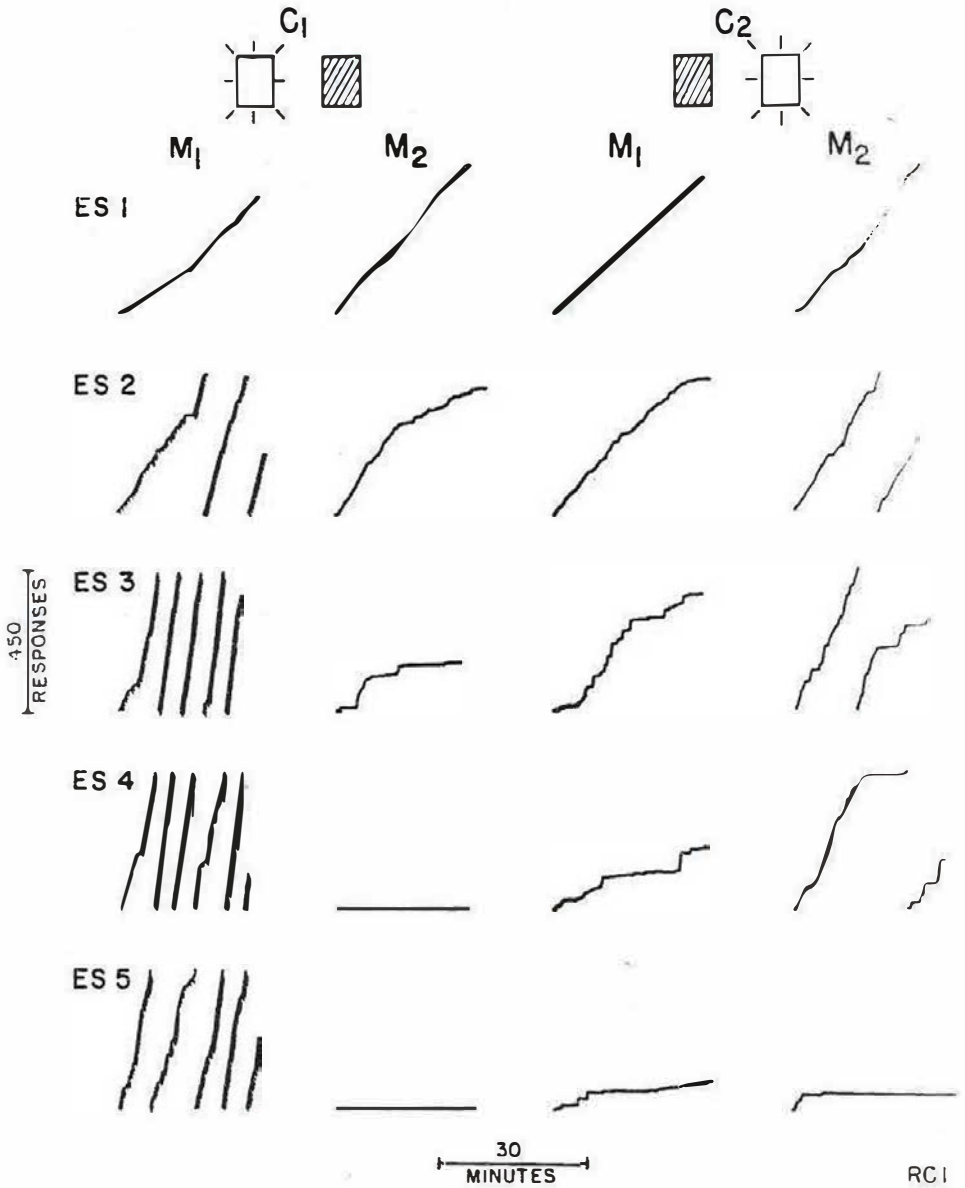


FIGURE 2. Slow, regular development of differentiation followed by discrimination and eventual cessation of overgeneralization. Hatch marks indicate delivery of a candy or penny for every tenth M1 operation under the C1 condition. Independent recording from each plunger (M1 and M2) occurs separately under each of the light configurations (C1 and C2).

the C2M1 rate had been slowly decreasing relative to the reinforced C1M1 rate, it was not until the fourth session

that this boy showed he had discriminated the light configurations. However, he was still overgeneralizing (pulling the

plunger under the light) as indicated by his still relatively high C2M2 rate. By the middle of the fifth session, it was clear that he had formed the discrimination and that he had stopped overgeneralizing: his C2M2 rate dropped to zero. The fact that he maintained this high level of efficiency throughout another five sessions (records not shown) indicates the clear stability of these processes in this child and assures that our conclusions about him are based on reliable behavior patterns.

The above sequence, beginning with undifferentiated behavior and successively showing differentiation of the plungers, followed by discrimination of the lights, and finally cessation of overgeneralization, is that shown by normal adults within the first 20 minutes of working for nickels under the same experimental conditions.⁹

	INITIAL STATE				FINAL STATE				RC NC (3)(2)
	C1 M1	C2 M2	C1 M1	C2 M2	C1 M1	C2 M2	C1 M1	C2 M2	
A	/	△	△	△	/	—	—	—	(1)
	/	△	△	△	/	—	△	—	(1)
	/	△	△	△	/	△	/	—	(1)
B	/	/	△	△	/	—	—	—	(1)
	/	△	△	/	/	—	△	/	(1)
C	/	△	△	/	/	—	△	—	(1)
	/	△	△	/	/	—	△	/	(1)
	/	△	△	/	/	—	△	/	(1)
D	/	/	/	/	/	—	—	—	(2)
	/	/	/	/	/	/	—	—	(1)
	/	/	/	/	/	/	/	/	(7)

FIGURE 3. Initial nondifferential behavior patterns (A–D) and their final states of differentiation and discrimination (1–5). Solid lines under Initial State represent initial reflex rates during the first 10 to 20 minutes of the first session. Arrows and dashed lines indicate the direction and relative amount of change which occurred before the end of the first hour. Under Final State, solid lines represent the most stable reflex rates over at least five consecutive sessions. Dashed lines and arrows show the relative amount and direction of variability in certain reflex rates of some subjects.

	INITIAL STATE				FINAL STATE				RC (4)	
	C1 M1	C2 M2	C1 M1	C2 M2	C1 M1	C2 M2	C1 M1	C2 M2		
E	/	—	—	/	2	/	—	—	/	(4)
F	/	/	—	/	5	/	/	/	/	(1)
G	/	△	/	△	6	—	—	—	—	(1)
H	/	/	/	/	3,4	/	△	/	—	(1)

FIGURE 4. Initial differential behavior patterns (E–H) and the terminal performances developed from each (2–6). Solid lines, arrows, and dashed lines are used as in Figure 3.

Summary of Operant Data

The initial and final performances of all subjects are summarized in FIGURES 3 and 4. Stylized cumulative records of each of the four reflexes (C1M1, C1M2, C2M1, and C2M2) are categorized according to the patterns (A through H) shown during the first experimental session (Initial State). The final states shown by children with each initial state are numbered to represent six types of asymptotic acquisition: (1) normal differentiation and discrimination without overgeneralization, (2) differentiation and discrimination accompanied by excessive generalization, (3) differentiation without stable discrimination, (4) discrimination without differentiation, (5) nondifferential behavior, and (6) "shirking" or cessation of plunger pulling. Bracketed numbers in the last column indicate the number of subjects who showed each type of final performance.

Since no other data of this nature were available on retarded behavior, the criteria of performance stability were empirically developed as the data unfolded from individual children during successive weeks. The device was programmed to define differentiation and discrimination functionally as relation-

ships between the rate of the reflex that pays off (C1M1) and the rate of each of the reflexes that do not.² This summary focuses on changes in relationships among rates rather than on absolute reflex rates.

Full acquisition of a given process, e.g., differentiation, was reached when the difference between the C1M1 payoff operations and the C1M2 operations was 80 per cent or more of their total for each of at least five consecutive sessions. If more than 25 per cent of a child's total C1M1 and C1M2 operations occurred as C1M2 (nonpayoff) plunger pulls, he was not considered to have demonstrated response differentiation. With children showing considerable session-to-session variability in any of the three processes, the number of sessions was extended to obtain a more reliable sample of their fluctuations.

Initial Nondifferential Behavior. Eighteen (72 per cent) of the retarded children and both normal children initially emitted all four reflexes at similar relative rates. Within this group, four distinctly different patterns developed before the end of the first session. These patterns (FIGURE 3) will be described and their relationship to final acquisition will be discussed.

Five retarded children and both normals maintained the reinforced reflex while all three nonreinforced reflex rates were markedly reduced or absent during the last 15 to 25 minutes of the first experimental session. This *rapid acquisition of differentiation and discrimination* (Initial State A in FIGURE 3) resembles the performance of normal adults working for nickels under identical conditions.⁹ Three of these retarded children and both normals further im-

proved their performance efficiency through six subsequent hours (Final State 1). Thus, their acquisition during the first experimental hour was consistent with that shown during subsequent hours.

Two retarded children, whose first-hour performances showed apparently normal, rapid acquisition of differentiation and discrimination, did not maintain this pattern. One child learned to differentiate without overgeneralizing by his seventh hour. Although he acquired and maintained stable discrimination from the third through the fourteenth session, slow loss then began to occur without recovery in 16 subsequent hours (Final State 3, representing fluctuation in C2M1 rate). The other child stopped overgeneralizing in the third session, but his behavior was subject to occasional loss of differentiation. His initial level of discrimination was slowly lost and not permanently regained in 34 hours (Final State 3, 4—a combination of patterns 3 and 4).

Rapid acquisition of discrimination without differentiation (Initial State B) was shown by one retarded child. Although this subject eventually reached complete acquisition of both differentiation and discrimination without excessive generalization (Final State 1) after 25 hours, the sequence of acquisition could not have been predicted from his first hour. Despite early signs of rapid discrimination without differentiation, maximal performance stabilized in the reverse order.

Rapid differentiation and discrimination limited by excessive generalization (Initial State C) was shown during the first hour by two retarded children. Although one of these children managed to

stop overgeneralizing by the fifteenth session, his initial progress toward discrimination became markedly variable from session to session throughout the next 30 hours.

Ten retarded children (40 per cent) showed relatively high behavior *output but no acquisition* (Initial State D) during the first hour. All four reflex rates remained substantially nondifferential throughout the first hour. Two of these children began to show differential rates by the third hour and eventually acquired the differentiation and the discrimination (Final State 1), one child in five hours of slow but very regular progress (FIGURE 2), and the other in 19 hours of erratic progress.

One child gradually formed the discrimination in nine hours through successive reacquisition at the start of each session. However, in 17 hours she had not differentiated the two manipulanda (Final State 4). Her characteristic pattern was rapid, simultaneous pulling of both manipulanda only under C1.

Seven of the children who showed nondifferential behavior throughout the first experimental session (28 per cent of the total group) retained this pattern without change for as long as 16 hours (Final State 5). They showed no evidence of forming either the plunger differentiation or the light discrimination, but their high rates indicated adequate motivation. Included in this group were two children who demonstrated an initial and persistent stereotypy of pulling the two manipulanda in regular alternation regardless of the light conditions.

The normal pattern of initial nondifferential behavior characterized the majority (72 per cent) of these retarded subjects. Rapid acquisition of either dif-

ferentiation or discrimination or both was shown by eight (32 per cent) of the retarded subjects within 35 to 45 minutes of the first session. However, subsequent fluctuations and/or losses, which occurred in most cases, required from 3 to 30 hours to reveal a final stable baseline which, in many cases, was not related to performance during the first hour. Six children in this group (24 per cent of the total) eventually acquired differentiation and discrimination without overgeneralization (Final State 1). Of these children, five showed the clearly definable acquisition sequence shown by normal subjects: response differentiation first, stimulus discrimination second, and gradual elimination of excessive generalization as the last phase of acquisition.

Initial Differential Behavior. Seven (28 per cent) of the retarded children showed behavior marked by differential reflex rates, immediately evident during the first few minutes of the first hour (Initial States E through H in FIGURE 4). The most striking was the prepotent pattern of pulling only the plunger under the light (Initial State E) at very high rates. In as many as seven sessions, the only acquisition shown by these four subjects was rate increase. Under the contingency arrangements commonly used in two-manipulanda, successive-discrimination experiments, these children would have shown a pattern interpreted as immediate acquisition of discrimination.

Another deviant pattern was pulling primarily one manipulandum at very high rates irrespective of light conditions (Initial State G). The only child who displayed this initial behavior developed a pattern frequently found in

chronic psychotic adults.⁹ After the first hour of high-rate responding primarily on M1, his behavior dropped off so sharply that from the fourth hour on, no reinforcers were earned (Final State 6). This subject was the only child who displayed clinically evident psychotic symptoms.

The most unexpected initial performance (H) was that of pulling at high rates predominantly with the right hand on the right manipulandum (M2, which never earned candies) by a child with residual right hemiplegia. Although the dominance later shifted to the payoff manipulandum, this child also developed a double pulling pattern in which she persistently worked against her handicap on a plunger which never paid off. In 17 hours the rate of simultaneous pulling under C1 eventually declined, but in 33 hours it had not permanently disappeared.

Not one of the children showing initial differential behavior reached the maximally efficient final performance state. In contrast with initial nondifferential patterns, the initial presence of differential behavior in these children is associated with continuing deviance and limited acquisition. Their prepotent behavior patterns, generated outside the laboratory, are remarkably resistant to modification by differential reinforcement. In addition, it seems that an apparent motor handicap does not necessarily preclude use of the impaired limb in this particular low response-force (300 gm.) free-operant situation.

Functional Definition of Reinforcement for Nonlearners

Throughout the above, we have referred to a variety of behavior reactions

under exposure to a pattern of differential "reinforcement." Those children who show clear evidence of stable discrimination (Final States 1 and 4) have, by definition, demonstrated that their behavior is controlled by the differential availability of candy and pennies under the two light conditions. Out of the total group, only 7 (28 per cent) clearly demonstrated by their acquisition patterns that the candy-penny mixture was functioning as a reinforcing consequence. Although most of the other children maintained substantial output under the conditions programmed, this fact alone gives no clear indication that their high rates were a function of the programmed consequence.

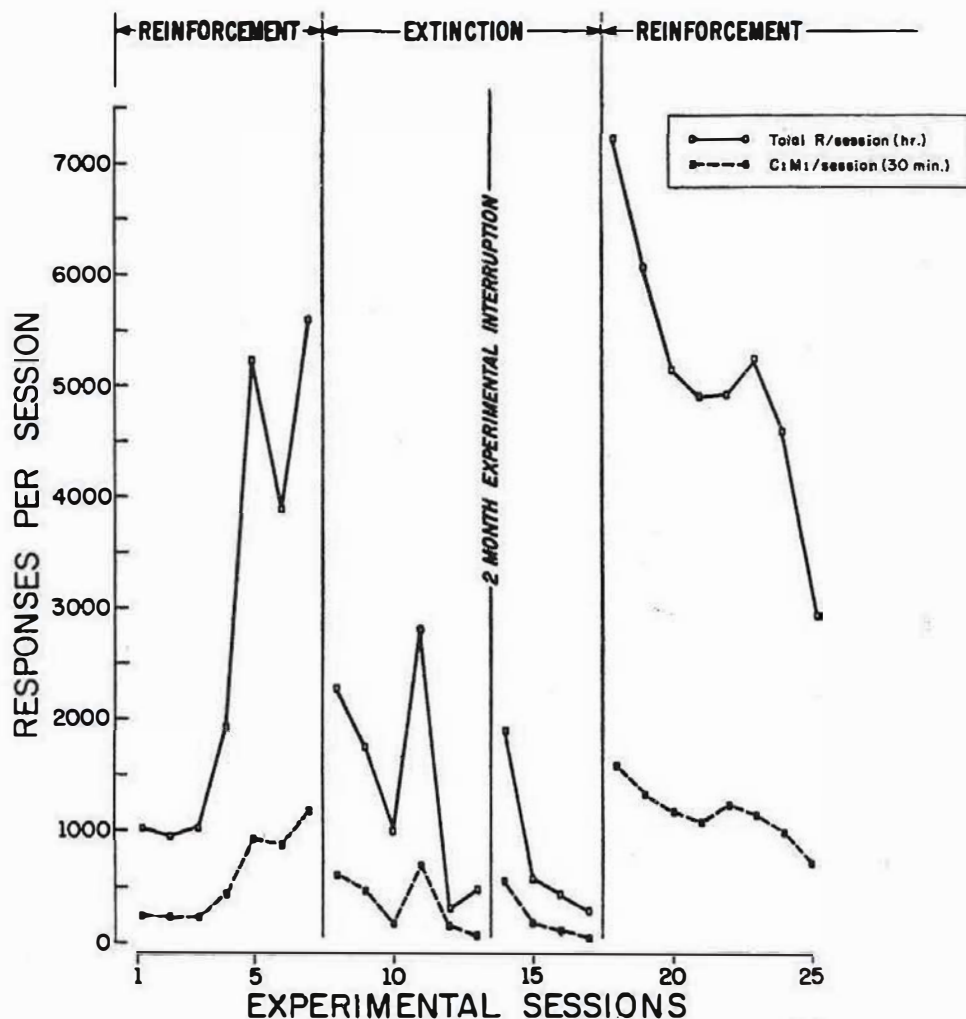
An operant reinforcer is functionally defined by its demonstrated control of behavior. In 72 per cent of our children, and most particularly the 32 per cent who persisted in nondifferential lever-pulling, the data summarized in FIGURES 3 and 4 present no empirical basis for claiming that their plunger-pulling movements were generated or sustained by delivery of candy and pennies. In addition, these data show no evidence that these 18 children have discrimination deficits until we have determined what sustains their behavior on our device. *We can not properly use the term "reinforcer" until we have empirically tested its operant function of behavior control.* Since individual preferences for different reinforcers vary greatly,¹¹ the function of a given agent should be tested individually on each child.

Subsequent individual analysis was undertaken to determine whether the candy-penny mixture was functioning as a reinforcer for those children who showed no acquisition (Final State 5).

The most direct evidence of the "effect" of a variable necessitates its withdrawal and subsequent re-presentation. The operant function of a response-contingent consequence is tested by programming a period of total extinction followed by reconditioning or reinstatement of the original reinforcement conditions.

FIGURE 5 illustrates the typical result of reinforcer-testing in our retarded non-

learners. This boy's random pulling of both plungers, irrespective of light conditions, throughout the first experimental session (Initial State D) persisted without change throughout seven consecutive sessions. However, his total reflex output increased during these sessions from 1,000 to more than 5,000 plunger operations per session, and his payoff rate (C1M1) from approximately 200 to 1,200



RC 6

FIGURE 5. Functional definition of a powerful reinforcer in a retarded child who acquired only increased rate of nondifferential behavior.

per session. The mere fact that his rate increased and that candies and pennies were earned by some of his plunger-pulling is no assurance that any functional relationship exists between these variables. He may just as likely have been responding for some unknown (nonprogrammed) consequence, such as the smile of a technician or the trip to the laboratory.

The following 10 sessions (8 through 17) were programmed on total extinction. When no candies or pennies could be earned, this boy's output slowly decreased until, by session 13, he emitted only 61 C1M1 plunger operations. After a two-month experimental interruption, the rate increase in session 14 gave clear evidence of spontaneous recovery, with rapid decrease in rate during the subsequent three sessions. Following extinction, re-reinforcement (beginning in session 18) produced a rate in excess of 7,000 per session (higher than any previous hourly output) and a median output of 4,895 per session for the next seven sessions.

This empirical test demonstrated that, although no differentiation or discrimination acquisition occurred, the candy-penny mixture was functioning as a powerful reinforcer to control this boy's high behavior output in a very lawful manner. Similar results were obtained with the other children showing the final no-acquisition state. For these particular children, the two plungers were functionally one, and there was no functional difference between the two light configurations. However, we cannot attribute their deficits in response differentiation and stimulus discrimination to an inadequate reinforcer.

Relevant Nonoperant Observations

Since the majority of social, medical, psychometric, and demographic data have not yet proved successful in predicting how individual retarded children learn, we did not design this stage of the research to examine the operant behavioral correlates of nonoperant variables. To provide the number of subjects required for an extensive statistical analysis, we would have had to sacrifice the intensity required for eventual experimental analysis of each child's acquired performance levels. However, in seeking clues to the potential heuristic value of our measuring device, we inspected some available institutional data.

When grouped according to initial and final behavior patterns (TABLE 1), the extent of overlap in the ranges of *age, psychometric scores, and duration of institutionalization* are so great that none could adequately predict or explain the operant acquisition data. Only a few suggestive descriptions emerge. Those children showing initial differential behavior and those who acquired the differentiation and the discrimination but continued to overgeneralize tend to be among the older children in the total group. Also, the latter group does not score as low in MA as the other subgroups. While some loose relationship to IQ may be suggested by the progressive decreases in median score for the Final State subgroups 1 through 6, here again the extent of overlap in ranges precludes definite statement.

Diagnosis, ward placement, and extent of verbal behavior were unclearly related to operant behavior patterns. Four siblings whose charts reported no posi-

Table 1

AGE, PSYCHOMETRIC, AND INSTITUTIONALIZATION DATA DESCRIBING INITIAL AND FINAL ACQUISITION STATES OF 25 RETARDED CHILDREN

	C.A. (Yrs.)		M.A. (Yrs.)		I.Q.*		Duration of Instit.		
	N	MDN.	Range	MDN.	Range	MDN.	Range	MDN.	Range
Initial state									
Rapid learning (A-C)	8	9.5	7-15	6.4	3.0- 8.2	60.5	52-72	2.5	2 Wks.- 7 Yrs.
Undiff. behavior (D)	10	11.5	7-17	5.0	2.9- 9.0	49.0	33-69	6.0	2 Wks.-11 Yrs.
Initial diff. behav. (E-H)	7	14.0	10-20	6.3	3.1-10.5	59.0	34-81	3.0	2 Wks.- 8 Yrs.
Final state									
1	6	9.5	7-15	7.0	3.6- 9.0	66.5	52-72	2.5	2 Wks.- 8 Yrs.
2	5	15.5	13-20	8.3	7.8-10.5	62.0	59-81	2.0	2 Wks.- 7 Yrs.
3 & 4	5	10.5	7-12	4.9	3.0- 7.3	56.0	44-65	3.0	1 Yr. - 8 Yrs.
5	8	10.5	7-17	4.8	2.9- 5.5	44.5	33-67	6.0	2 Wks.-11 Yrs.
6	1	15.0		4.7		34.0		8.0	

* Primarily Binet L.

tive medical findings showed patterns ranging from state 1 to state 5 in final acquisition, thus overlapping most categories shown by children with varieties of medical diagnoses.³ Formal diagnoses on the only child exhibiting the most severely defective pattern (Final State 6) associated with severe chronic psychosis^{9, 11} contained no mention of his psychiatric status. One year after our initial study reported here, his psychotic condition became evident to the personnel of his dormitory.

Ward placement and general level of verbal behavior also overlapped among the categories of initial and final states. However, neither of these variables was systematically studied. Clear-cut criteria for ward placement were not obtainable. Early efforts to get oral and gestural reports from each child on what he did during each session in the experimental room, e.g., which plunger(s) he pulled, what the lights were for, etc., resulted in wide intrasubject variability from session to session and a broad range of replies that most often bore no relationship to what a given child actually did.

School progress was checked informally through brief interviews with the teachers of children showing selected behavior patterns. Although no attempt was made to rate the teachers' verbal reports, the ends of our laboratory-defined behavior continuum were clearly associated with teachers' global statements of classroom progress. Our subject showing the most regular and stably maintained acquisition (FIGURE 2) progressed two grade levels in one academic year. The child in our group who persisted in the longest period of completely random, nondifferential behavior was said to have made no progress during three years in the same class. Shortly after this phase of our study, he was dropped from the school program.

Four of our subjects persisted in extremely low-rate behavior (less than 300 resp./hr.). Subsequent analysis⁵ demonstrated that their low rates were not due to a weak reinforcer. A check of their histories and current treatment revealed that all four children in our group who persisted with rates below 300 per hour following the first session were on

anticonvulsant medication (usually Dilantin and phenobarbital), some since infancy or early childhood despite absence of convulsions for many years. Three other children on anticonvulsants emitted higher-rate behavior. None of the 18 children without anticonvulsant medication showed the low-rate pattern.

Only one child initially refused to remain in the experimental room with the *door closed and locked*. During his first two sessions the door was left slightly ajar with no apparent distracting effects on his operant behavior. Toward the end of the third session this child was interrupted by an older boy who entered the room, shoved him out of the way, and proceeded to operate the machine for what our subject would otherwise have earned. Following this intrusion, our subject requested that the door be locked during subsequent sessions.

IMPLICATIONS AND CONCLUSIONS

An instrument reliable enough to permit detailed, automatic measurements on each retarded child continuously throughout his course of acquisition has revealed a number of behavior characteristics pertinent to both the methodology of laboratory behavior analysis and to the design of evaluation and training procedures. Ideally, laboratory analysis and practical application should mutually nurture each other's progress toward increased specificity and effectiveness of behavior description and techniques for its modification. The following sections will suggest some of the implications of our initial findings both for the remedially-oriented experimental researcher and for the experimentally-oriented (empirically-oriented) habilitator of retarded children.

Characteristics of Retarded Discrimination Acquisition

Variable acquisition time and course. Retarded learning is most often described as "slow." The implication is that speed of acquisition is the primary dimension distinguishing the acquisition process of the retarded child from that of the more nearly average child. Accordingly, the training of such children is most often a geared-down, diluted version of what the average child of younger chronological age can handle. The expectation is one of uniformity in level of performance, both intrasubject across tasks and intersubject on the same task. This notion has been amply supported by reference to the usual absence of "scatter" in the performance of retarded subjects on single time-sample standard tests of general intelligence. It has not been supported by unbiased, careful observation of the daily behavior of retarded children or by the exceptionally high subskills so frequently overlooked in many members of the adult retarded population.¹³

To describe retarded learning as "slow" is to mask a wide range of highly varied behaviors with convenient oversimplicity. Only one child (RC1 FIGURE 2) in our group of 25 displays the gradual, orderly, but very slow progression traditionally represented by the negatively accelerated learning curve fitted to averaged group data. Multiple, continuous measurements disclose marked intersubject differences in both the course and the final level of acquisition. Some retarded children acquire the maximally efficient final state as rapidly as normal "average" adults. Others show high and stable behavior output but no acquisition in 30 hours of exposure to

the same training contingencies. Between these extremes are children who form the differentiation, the discrimination or both within a wide range of acquisition times. Neither verbal facility, psychometric score, age, nor duration of institutionalization can predict either the final performance levels or the time required by individual children to reveal their own enduring performance characteristics.

Varied sequences of reflex formation occur during the course of acquisition. Many children display marked irregularities in rate of reflex formation. Nonretarded adults and children acquire the response differentiation first, followed by discrimination of the differences between the light configurations, and, last, control of overgeneralization. Although many of our retarded subjects follow this acquisition sequence, 20 per cent deviate from the expectation derived from "normal" data. Some suffer apparently spontaneous losses of various durations, with and without recovery, before reaching a final state.²

Wide intersubject differences in acquisition time within the constant, automatically controlled environment parallel the individuality of progress made by retarded children in training and educational environments. Provision for a wide range of individually different learning rates has long been stressed in discussions of teaching methods and curriculum design for nonretarded but otherwise specifically handicapped children. The extremes demonstrated within our group of retarded children suggest even greater need for individualized training expectations of and techniques for students from the *retarded* population. On certain tasks some retarded

children acquire the performance level of normal adults even more rapidly than average children of the same age. Unless their teachers observe and differentially respond to the nonretarded and even superior aspects of their performance, their potential competence in specific subareas may remain undeveloped due to neglect. Other children whose behavior appears unmodifiable may either be truly very "slow," and thus require special environmental modifications, or may demonstrate extreme irregularity in their protracted course toward a well defined performance level. If prematurely terminated in a training or investigative program, the level of their eventual performance never will be known. Age, quality of verbal behavior, and psychometric scores are risky selection criteria which may well exclude children capable of performing well beyond the expectations traditionally associated with norms derived from data on nonretarded children.

Unreliability of Initial Behavior Patterns. A child's initial pattern and rate of change do not predict the course or final state of his performance. Conversely, we cannot assume a common initial state from similar final performance characteristics. A number of children who appear to show rapid acquisition during the first hour of conditioning subsequently develop variable patterns, inconsistent with their initial progress. Some children who achieve the most efficient pattern of final performance start with no evidence of acquisition throughout their first hour. Although the presence of differential behavior from the outset is associated in these data with a truncated upper limit of final performance, here again the initial patterns of

three out of the seven children in this subgroup are not clearly related to their eventual performance efficiency.

Observant teachers and clinicians have long commented on the dangers of educational placement and remedial treatment based on the brief evaluations so common in psycho-educational assessment practice. Our data underscore the need for a more intense, long-term, individual evaluation of retarded behavior under conditions which provide ample opportunity for each child's abilities and deficits to emerge, to be objectively recorded, and to be appraised with respect to their *demonstrated* modifiability under specified conditions, rather than their static level at initial assessment. Quite clearly, the modifiability of their behavior is not predictable from a brief assessment of their current behavior repertory.

While most teachers of retarded children have learned to withhold appraisal of a child's behavior pending its stabilization over an extended time, the researcher frequently neither familiarizes himself with the teacher's practices nor questions the reasons for them. Selection and evaluation of children for research purposes are routinely based largely on short-term exposure to pretraining tasks, brief pretests, and/or psychometric scores. Our data suggest that short-term criteria for selection may result in training results that are confounded with the subject's *natural* course of acquisition. By excluding children who show no immediate acquisition, one risks omitting a number of the most efficient learners. If only the children showing rapid acquisition are selected, their subsequent highly variable patterns may create sufficient "noise" to cancel out the potential

effects of training variables. Although initial differential responders may appear already well equipped with the behavior components necessary for a specific task, these children may turn out to be among the most resistant to differential reinforcement. Also, the presence of prepotent behavior patterns could confound results in multiple-response situations designed on the assumption of equally distributed response probabilities.

Instability of Acquired Behavior. In addition to individual differences in time and course of acquisition, the range of final performance stability differs markedly among retarded children. The majority of our subjects eventually acquire enough stability in their relative rates of reinforced and nonreinforced reflexes to make their behavior patterns readily predictable from session to session. However, temporary variations occurring within hourly sessions are more the rule than the exception, not only during acquisition, but also as an enduring feature of eventual performance efficiency. Some children with repeated sessions of generally nondifferential reflex rates may cease emitting a nonreinforced reflex for 10 to 15 minutes or even a good part of an hour, only to resume its emission after a temporary hiatus. Other children who may emit *only* the reinforced reflex for 45 minutes or even an hour or two may relapse into temporary episodes of emitting any one or more of the nonreinforced reflexes. If a child is provided with a sufficient number of sessions, the variability in most of our retarded subjects is eventually reduced to intersession differences in relative rates of less than 20 percentage points. However, some children continue to show marked intra-

session variability and intersession differences in relative rates exceeding this range. Although their discrimination and differentiation patterns are variable, each child's range of variability eventually becomes stable.

To determine the most reliable (predictable) pattern of *naturally* acquired performance, it is necessary to "wait out" each child until his own range of variability becomes clear. Children with the widest range of session-to-session variability necessarily require the greatest number of sessions to reveal their naturally developed asymptotes and thus to define individually their maintenance baselines of previously acquired behavior.

Thus it appears that brief periods of differential behavior emission rates may be quite deceptive in the functional definition of a reliable versus a transient behavioral state. A retarded child who today may initially respond without error on a given task may show errors on the same task tomorrow or even later today. Short samples of performance, commonly employed in assessment and selection procedures, are thus likely to yield unreliable information on the specific abilities of many retarded children. Performance increments under repeated exposure to criterion tasks and individual test items will disclose an often higher and always more reliable level of behavior competence than is yielded by a single presentation. Simple repetition of test items may reveal changes in scores similar to those obtained with "coaching" and other training techniques whose apparent effects may be confounded with natural acquisition that might have occurred in their absence.

In the classroom, repeated checking

of previously generated behavior may confirm our finding that the variables sufficient for acquisition to occur are not always sufficient to sustain the acquired behaviors. A child who learns certain behaviors under one set of conditions may require a different combination of variables to maintain those behaviors. After initial learning, some children may perform more accurately without all the trappings considered necessary for their instruction. On the other hand, many retarded children may need additional "props" to sustain their use of newly acquired behaviors. It has been amply demonstrated in research on small animals that behavior acquisition and maintenance require different conditions.⁸ As an example from research on humans, one of our retarded subjects (RC 16) reported earlier² acquired no differential behavior pattern until he was reinforced for every third, rather than every tenth, "correct" reflex emission. Once having acquired both differentiation and discrimination without overgeneralization under a very small reinforcement ratio, he was later able to maintain efficient responding under a more intermittent schedule of reinforcement. The implications of these findings for the prosthesis of retarded behavior have been discussed by Lindsley.¹²

In the methodology of laboratory research, selection of suitable criteria of stability in ongoing behavior often has neglected the mounting evidence of individuality and inconsistency in human behavior emission. While our data on retarded behavior reveal considerably less variability in most subjects' behavior than Lindsley's¹⁰ free-operant data on chronic psychotic patients, both bodies of data show greater intraindividual vari-

ability in pathological subjects than in normal subjects under identical intermittent schedules of reinforcement.

When coupled with a wide range of individual differences in both the time and the sequence of acquisition, the instability of retarded performance reemphasizes the danger of selecting *a priori* criteria of learning based on data from any *other* subject group, either human or animal. A given level of performance maintained for 15 minutes or even a few hours may, under extended study, turn out to be simply a temporary plateau in a highly erratic course toward a higher level. A predetermined number of sessions or a preselected duration of behavior stability used as arbitrary limits may truncate the range of acquisition and thus obscure the final product from many children. Unfortunately, many studies of retarded learning have not given adequate opportunity for full acquisition to occur or for individual defects in behavior maintenance to be revealed. Unless criteria of behavior stability and determination of final acquisition states are reached empirically for each child, demonstrations of performance improvement under selected variables and selected programs are likely to confound experimental effects with behavior in the process of spontaneous change.

Specific Deficits in Independent Processes. The mere fact that the apparatus was programmed for separate, simultaneous measurement of three different behavior processes in no way substantiates their difference. Only the interaction of the subject with the apparatus can establish the functional independence of the emitted behaviors.

The sequential characteristics of ac-

quisition shown by our child subjects (retarded and nonretarded), as well as by Lindsley's⁹ normal and psychotic adults, reveal different rates in formation of response differentiation, stimulus discrimination, and control of overgeneralization. Normal subjects acquire these processes in the above sequence, but usually so rapidly that their independence is not clearly demonstrated. In many retarded subjects, acquisition is sufficiently slow and the temporal dimensions of behavior change are so expanded that the activity of component processes may be easily observed. Different sequences in formation of the three measured processes are clearly demonstrated.

As a more reliable indicator than acquisition time, the varieties of final levels of performance among the retarded children again show independence of and specific deficits in each of the processes functionally defined by the child's interaction with the apparatus and its program. Furthermore these deficits are not a function of an inadequate reinforcer. The child who discriminates the lights may not have formed the response differentiation (Final State 4). In this case the physical presence of two plungers is unrelated to their functional use. The child pulls them as if they were a single plunger, but only under the light condition signaling availability of reinforcement. Having learned the difference between the "payoff" and "nonpayoff" plungers, a child still may not discriminate to the differences between the light configurations (Final State 3). Thus, although the lights are positioned differently, for such a child they are functionally identical. He operates only the "payoff" plunger, irrespective of the light signals delivered by the device.

Excessive generalization or deficient generalization-testing may occur independently of response differentiation and stimulus discrimination (Final State 2). It appears that for the most efficient performance a third process is necessary to check on the appropriate emission of previously formed reflexes. In its absence, children who have acquired both response differentiation and stimulus discrimination may continue to overgeneralize ("pull the one under the light") under conditions that never have reinforced their behavior. It also should be noted that each of the three processes is independently subject to session-to-session variability within individual children. A child with stable differentiation may have highly variable discrimination, while the reverse may characterize another child's final performance.

Location of specific deficits in three of the independent component processes in discrimination learning raises considerable question regarding the adequacy of many conventional assessment and training procedures which assume a unitary process.⁴ Tasks which require a choice between two or more responses to indicate a difference or similarity between two or more stimuli may confound these processes. Failures then may be attributed to a deficit in whatever the task-designer *thinks* he is measuring or teaching: discrimination, generalization, concept formation, language comprehension, object recognition, and the like. Both clinical and laboratory assessment procedures which assume the presence of component processes in mentally retarded subjects likely will ascribe defective functioning to one of the higher order processes, when a more basic deficit may remain unmeasured.

In the classroom a child who appears deficient in his current ability to discriminate two or more simultaneously presented forms actually may be unable to differentiate the movements required to indicate his correct choice. Any request such as "show me," "point to," "where is," "which one," etc., with respect to an array of different stimuli demands execution of the previously differentiated movements. The child who responds in random fashion most often is thought to be deficient in his discrimination of the component stimuli. His more basic deficit may be a current inability to differentiate one response from another within the same response class. One wonders how often apparent deficiencies in discrimination of simultaneous stimuli might disappear as a result of training in so-called response learning. To select the training methods most suited to the current abilities of each child and thereby to prevent the experience of repeated failure so often encountered by both retarded students and their teachers, the component behaviors involved in each task should be *demonstrated* rather than assumed. In view of marked interindividual differences and the degree of intraindividual variability found in the performance of retarded children, behavior-component demonstrations should be done independently on each child and at frequent intervals prior to use of training procedures demanding these basic skills.

Similar precautions apply in the design of experimental laboratory tasks and devices for programmed learning.⁴ Operating switches under stimuli in sequentially different positions involves elements of both "response learning" and "stimulus learning." The behavior

process is different from successive-stimulus discrimination requiring operation of only one of two or more available switches. Further analysis also may show that simultaneous-stimulus discrimination is a process independent from response differentiation within the same response class. If so, those animal studies in which the response spectrum is experimentally limited to use of a single effector (e.g., pigeon beak) or by the availability of two or more physically incompatible response choices (e.g., two or more alleys in a maze, when only one may be entered at a time) should be reappraised with respect to their relevance to the behavior of humans with multiple effectors, capable of simultaneous and synchronized functioning. In any event, since retarded subjects show differential acquisition of and specific variability in response differentiation and stimulus discrimination, more thorough experimental analysis of their current learning abilities should yield data of increasing relevance to the remediation of specific deficits in the behavior of individuals.

Some comparisons with psychotic behavior. The most frequent question raised by these data concerns the differentiation of psychosis from mental retardation. The area of differential behavioral diagnosis by fully-controlled free-operant techniques deserves far more lengthy consideration than current space permits. However, a summary overview of the findings on psychotic patients^{9, 11, 12} compared with our initial findings reported above should yield a hopeful note to all workers in the field of mental retardation.

Twenty-five per cent of our retarded children showed no deficits in their cur-

rent discriminative and differentiative behavior as compared with approximately 10 per cent of psychotic adults, seniles, and psychotic children. Twenty-seven per cent of Lindsley's psychotic adults (with previous histories of more than 100 responses per hour in a single-plunger, simple free-operant situation) stopped responding in the discrimination situation requiring more complex behavior processes. Only one (4 per cent) of our subjects withdrew in this manner. A more dramatic comparison is revealed in the differential reaction of adult psychotic patients and mentally retarded children in the simple single-plunger operant and the more complicated multiple-reflex situation. Eighteen per cent of the psychotic adults either initially or eventually refused to enter the single-plunger experimental enclosure. None of the retarded children refused to enter the more complex discrimination enclosure. On a single plunger, only 65 per cent of the psychotic adults emitted enough behavior for experimental analysis. In the more complex task, 96 per cent of the retarded children (including those on anticonvulsants) emitted sufficient behavior to permit experimental analysis of their discrimination and differentiation abilities. In total absolute rate (responses per hour), most of the retarded group, in the complex discrimination enclosure, maintained an output considerably greater than the majority of psychotic children and adults.

Our institutionalized retarded children emit far more adjustive behavior than the chronic psychotic patients or the institutionalized psychotic children studied by similar methods. They are more responsive in a novel situation and are much more amenable to behavior modifi-

cation by consequential events within their immediate environment. Their behavior deficits in a controlled environment are far less debilitating than those of the psychotic adults and children. Given sufficient time in a novel learning environment with a consistent pattern of differential reinforcement, institutionalized retarded children are far more likely to develop complex behavior repertoires than are psychotic children and adults.

While these comparisons may be welcome to the habilitators and teachers of retarded children and criticized as irrelevant by the therapists of psychotic patients, they sound a thought-provoking note for clinical and educational administrators in institutions for the retarded. Despite low and often unobtainable psychometric scores, school failures, absence of current verbal repertory, and varieties of organic involvement, most retarded children respond more sensitively to environmental manipulation than do psychotic patients whose behavior disorders popularly have been attributed to environmental factors. Many of the children considered untrainable and left to fixate a television set, to rock in a corner, or to mutilate themselves or others may be acutely responsive to the consequences their behavior produces from their inordinately barren ward environments. Their daily behavior patterns may be more a product of their immediate surroundings than of their pathogenesis. As such, their current repertoires, as sampled by brief evaluative procedures, are unlikely to represent their current *amenability to behavior change* under more appropriate environmental conditions. The wide range of individual patterns developed through

time in a constant, controlled environment strongly supports the notion that more individualized training environments and procedures will furnish, in the long run, more efficient and thus more economical assistance to the developing retarded child. The results may be far more convincing in training schools for retarded children than in hospitals for psychotic patients.

FUTURE DIRECTIONS

The different behavior patterns generated within a constant, automatically controlled, and thereby reliably responsive environment provide a starting point from which to pursue increasingly specific delineation of individual deficits and abilities. Two general strategies assist in the tactical decisions governing further development of the method: functional analysis of the obtained behavior deficits and functional calibration of the deficit measurement procedures for broader applicability.

Functional Analysis of Defective Processes

Our initial group of institutionalized retarded children presents us with a broad array of naturally acquired "terminal" performances. To describe a deficit in terms that may assist in its remediation or prosthesis requires more than measurement of its severity in one "test" environment. A single, uniformly constant conditioning environment is not likely to generate or sustain maximum performance in children with very different behavior requirements. The most heuristic description of a behavior deficit includes not only its degree of severity

under known conditions, but its differential reaction to various manipulations of these conditions.

Thus far we have seen that the immediate learning environment consisting of the experimental chamber, the device, and its program can be used not only as a vehicle for observation but as a means of sorting individual behavior patterns into reliably defined deficit categories. Our next questions: How amenable are these deficits to modification by discrete changes in the conditioning environment? What changes in this environment are not only sufficient but necessary to produce more efficient performance in children with known experimental histories and specific deficits? Is the behavior change permanent or only temporarily prosthized by the presence of certain environmental "props"? Do children with identical deficits react similarly to identical "treatments"?

Starting with the final states acquired by each child, we will determine the functional relationships between his current performance and those variables in the immediate learning environment which either sustain or modify his deficits. For those children with normally efficient final-state performance, we will present a new problem which may locate a deficit not yet revealed. In such cases, our analysis will focus on the new deficit.

With functional analysis of individual behavior deficits, it should be possible to evolve a set of specific behavior-deficit categories described not only by their severity but also by the conditions under which they appear and, hopefully, disappear *in each child*. Functional prescriptive descriptions of individual deficit patterns should be of greater use to

the teacher, the programmer of training material, and the habilitator than the static quantification system employed in current assessment techniques.⁴

Functional Calibration for Individual Differentiation

The method of simultaneous measurement of response differentiation and stimulus discrimination permitted the emergence of individual patterns of speed, sequence, and asymptotic performance. More important for purposes of individual behavior description, when employed as a vehicle for automatic behavior observation and measurement, the method disperses the obtained inter-subject differences along a very broad continuum from the efficient, economic performance characteristic of most normal adults to the most debilitating behavioral deficiency found in severely ill chronic psychotic patients. The stylized, summary cumulative records presented here are not meant to demonstrate the full extent of behavioral individuality obtained by this method.^{2, 5} Hourly rates; local rates; the number, duration, and distribution of pauses and spurts of behavior (those aspects of behavior that are continuously, cumulatively recorded with this method) reveal characteristics that are readily identifiable for each child.^{3, 5} As the research proceeds, more detailed descriptions of individual patterns will be presented.

The temporal distribution of continuously measured behavior, freely emitted within a constant, controlled environment, is acutely sensitive to those idiosyncratic variations and irregularities of human behavior that defy accurate recording or description by the

human observer. The use of multiple and simultaneous continuous measures provides the advantage of recording ongoing interactions among the reflexes under investigation and thereby augments the spectrum available for more precise laboratory description of individually different behavior patterns. Since the method is designed to delineate individual differences within a recognized deviant segment of the population, the extremes of the spectrum it yields should be defined not by the *a priori* judgment or assumptions of the investigator, but functionally by the data obtained from individuals representing clearly agreed "normalcy" at one end and severe behavior pathology at the other end. Unless the device is to be used for comparative study, little will be achieved by extensive balanced sampling from nondeviant (normal) population subgroups.

The normal end of our continuum closely follows the patterns shown by Lindsley's group of normal (nonhospitalized) adults.⁹ The pathological end needs further clarification. Our initial sample of retarded children does not adequately represent the scope and severity found in institutionalized populations. If our device and/or its program are to be most useful in a functional analysis of retarded behavior, they should be capable of application to the entire range of this population.

Further research will focus on those children popularly described as severely and profoundly retarded. Modifications in the device and/or in its program (if they are found not only sufficient but necessary to measure the differentiation and discrimination of these children) will further specify the functional de-

scription of the children's behavior. At present, severely defective behavior is defined primarily by its exclusion from more average educational and social environments with instruments designed precisely for this screening-out purpose. Maximally defective behavior is thus subject to the greatest homogenization via instruments calibrated on normal children. One of our future tasks is to differentiate the types of individually-specific behavior deficits and abilities within this subgroup of retarded children by permitting *their* behavior to functionally calibrate our measurement devices and procedures.

SUMMARY

A method for simultaneous and continuous measurement of free-operant response differentiation and stimulus discrimination was employed as a vehicle for exploring the varieties of patterns shown by institutionalized retarded children as they acquire their own stable performance levels. Specific deficits in functionally defined behavior processes were located. Response differentiation and stimulus discrimination were demonstrated to be independent processes differentially vulnerable both to deficit and to spontaneous fluctuations and loss. High intraindividual variability in many children required long-term evaluation.

Intersubject differences in acquisition speed, sequence, and efficiency, as well as in performance stability, were distributed over a broad continuum ranging from performances characteristic of normal adults to the behavior deficiencies of many chronic psychotic patients. Neither age, psychometric scores, duration of institutionalization, verbal facility, nor diagnosis could ac-

curately predict individual performance efficiency; however, the ends of the laboratory-defined continuum were related to school progress. Some implications both for training and for laboratory research were suggested.

Clearly, retarded learning is more than simply "slow" learning. Its multifaceted complexity deserves increasingly more specific functional description and analysis before remedial techniques can be designed for optimal effectiveness with individual children. Culture-free, nonverbal, fully controlled, free-operant techniques hold considerable promise for revealing properties of retarded behavior hitherto shrouded by insensitive measures standardized on nonretarded populations. The results may upset many long cherished beliefs and expectations. Habilitation oriented experimental analysis of each child's interaction with a bias-free, reliably responsive measuring environment may give his behavior a chance to "speak" more dramatically and surely more functionally than words.

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