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Renewal Proposal Abstract

A BEHAVIOR EVALUATION PROGRAM FOR RETARDED CHILDREN

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A. Specific Aims

1.0 The Problem. Are we giving all retarded children equal opportunities to learn? What is our evidence that our habilitative programs are reaching all children who might benefit? How confident are we that children assigned "custodial" status have really reached their upper behavioral limits? Are our institutional programs geared to sustain the most competent behavior in these children? Can we produce assessment procedures that might reveal unrecognized abilities within this "hopeless" segment of the retarded population? If so, can we design training procedures specifically applicable with the children who will, one day, constitute the major element of our institutionalized retarded population? These children with the most severe deficits offer the greatest challenge to the evaluator and habilitator. About these we know the least; from them we should learn the most.

The first two years of three approved for NIMH support have enabled us to begin exploring the usefulness of automatically programmed conditioning procedures for locating habilitatively relevant features of retarded behavior. Local support (state, institutional, and parental) has collaborated to construct and partially staff a large facility specifically designed for the development of objective laboratory techniques to analyze and modify behavioral retardation throughout its range of severity.

During 16 months of daily operation, we have partially tooled this facility with a series of automatically controlled behavior evaluation chambers. We have begun to locate and quantify specific abilities and deficits in basic visual and auditory discrimination and to delineate individual motivation profiles among a wide range of retarded children. We have demonstrated that our techniques are applicable to many of the so-called untestable children we selected for study. However, we have yet to reach many of those children currently considered untrainable who are now herded in barren day rooms, restrained in cribs, or simply fed, diapered, washed and turned.

To provide equal learning opportunities for all retarded children, it is mandatory that we develop fully objective techniques to reveal the behavior properties of this exceptional population throughout its full range. Findings from our first year of operation have revealed behavioral competence in children considered hopeless in training potential. These promising early results indicate that laboratory analysis procedures can be adapted to bring profoundly retarded children within the range of a single direct, functional measurement system for all behavioral retardation.

2.0 Specific Aims. This application seeks renewed support to extend the applicability of our laboratory behavior evaluation techniques to encompass the widest possible range of retardation. In addition, we will explore the

functional value of these techniques in promoting an institutional habilitative climate more closely geared to the behavioral capabilities of individual children. We plan to focus our methodological developments on younger severely and profoundly retarded children whose opportunities for behavior development have been severely curtailed by prevailing notions of their behavior potential. By demonstrating that their behavior is not only measurable but also modifiable within the laboratory environment and by relating their ward behavior to the patterns revealed in the laboratory, we hope to design efficient individually-tailored ward remedial procedures which will work for each child.

The ultimate goal of our original proposal remains unchanged: To provide a battery of fully objective laboratory procedures to supplement clinical techniques for describing, predicting, and modifying the behavior of mentally retarded persons. Our broad aim is to improve the efficiency and effectiveness of diagnostic and training procedures for behaviorally deficient children by developing and applying techniques of laboratory behavior analysis that permit more precise measurement, analysis, prognosis, and prescriptive description of individual abilities and deficits. More direct, objective evaluative tools should diminish the necessity for speculation and subjective judgment, and thus should allow the child's behavior to speak for itself without superstition, bias, or rationalization.

Our program of exploratory, developmental, and applied investigation, as outlined in our original proposal, is still primarily in its initial phase. The first steps involve a) precise delineation of specific abilities and deficits in children with varying degrees of retardation, and b) exploration of the immediate environmental conditions that enable each child to perform most efficiently. The progress we have made in designing, constructing, staffing, and partially equipping the laboratory has been accomplished at the expense of more widespread contact with the institutional personnel directly concerned with child care and training. We still have a long way to go both methodologically and in terms of our in-service training function. The fact that we have acquired salaried personnel from both the Nursing and the School Department of the institution puts us in a more favorable position to develop the lines of communication and application-feedback necessary for maximum utilization of our methods and findings.

We believe we are just beginning to emerge as a potentially useful resource to the children, the institution, the Commonwealth's Department of Mental Health Programs, and other related programs throughout the country. With continuing support, we hope to demonstrate the value of a daily working relationship between a clinically-oriented behavior evaluation laboratory and the personnel directly involved with training institutionalized retarded children.

B. Significance

A behavior-oriented approach to the diagnosis, prognosis, and treatment of retarded children will render greater general educational and service value both to the institutional staff and to the retarded residents, if its techniques are applicable to all types of problem behavior. Severely disruptive and poorly understood behaviors are found in children with whom conventional assessment procedures are inapplicable. Prognosis is nearly always considered so poor that little if any effort is spent on their habilitation.

As our institutions become more specialized in their admission policies, severely deficient children will soon comprise the greater percentage of the resident population. At present, these children are the subject of occasional

medical investigation and treatment, but their behavior remains largely unmeasured and often attributed to permanently damaged functions. As a result, they are usually excluded from habilitation, special education, and general ward training.

By extending our laboratory evaluation methods and applications to the least understood institutionalized group, and by developing systematic, daily communication about these children with the teaching and nursing personnel working with them, we hope to stimulate a more empirical, open-minded approach among the nursing, habilitative, and educational staff — one which concerns itself with developing new behaviors rather than emphasizing deficiencies. Children heretofore considered ineligible for training of any type can and have been demonstrated to have objectively measured behavioral competence. Demonstrations of their laboratory-measured abilities should help focus activities of the attendant personnel on devising ways of encouraging higher levels of behavior in each child. The usual alternative is the non-child-oriented housekeeping approach currently practiced in many institutions.

Techniques for generating and sustaining the most efficient levels of behavioral competence in the very young, severely retarded children should prevent behavioral deterioration. Such deterioration is observed to occur with prolonged exposure to non-behaviorally-supportive custodial environments. In addition, the data yielded on profoundly retarded children will provide objective behavioral bases of value in clinical neurological diagnosis.

Our laboratory methods are designed to analyze the functional relationships between a child's behavior and selected variables in his immediate environment. We can demonstrate that these methods show the degree to which simple component behaviors can be modified by the social and/or non-social consequences each child's behavior produces from his environment. This fully objective evidence will back up Fernald's In-Service Nursing Education focus on developing the behavioral capabilities of each child. Strategically designed laboratory analyses will demonstrate the importance of the immediate environment, including the attendant, in stimulating and reinforcing increasingly developmentally advanced behavior in severely retarded children.

Reinforcement procedures applied to behavior development provide constant feedback as an immediate indication to the attendant of the effectiveness of her efforts. The self-corrective feedback, inherent in this approach, makes it an excellent demonstration-teaching method for all disciplines involved in child training.

Individual differences, which emerge so clearly in the laboratory, will furnish a reliable basis for designing individually tailored learning environments to support the most efficient behavior in each child. As we further develop our procedures for increasing habilitative-relevance, we will be able to determine the types of cues each child is able to use most effectively and the motivating conditions that best sustain his efforts to deal with his environment. This type of information should prove useful in developing more practical, objective criteria for placing children in specific training programs. Techniques which measure behavior modifiability in equivalent units throughout the range of retardation will provide common dimensions on which to make direct behavioral comparisons across diagnostic subgroups irrespective of the degree of retardation. Differential planning for each child will be facilitated by reference to his location on various behavior continua defined functionally by the demonstrated extremes of retarded behavior.

Our procedures are being designed for multi-channel, long-term, continuous measurement of simultaneously emitted symptomatic and adjustive behavior. The sensitivity of these procedures permits us to trace both immediate and delayed effects, in individual children, of various pharmacologic, dietary, or environmental treatments, and to assist in determining the most efficacious form of treatment for each child. Longitudinal studies of individual children can be conducted continuously over years with assurance of complete reliability of the measuring device. Evaluative instruments with these capabilities will underscore the inseparability of assessment and management and will emphasize behavior modification as a primary focus for behavior assessment.

Finally, we hope to show how experimental behavior science and practical application mutually enhance each other's progress toward more definitive and more efficient techniques for describing and habilitating retarded behavior.

C. Facilities Available

The Walter E. Fernald State School is one of four state schools for the retarded in the Commonwealth of Massachusetts. Its population numbers approximately 2500 residents of all ages and at all levels of retardation. In residents, staff, and programs, it is representative of most other institutions throughout the country.

Fernald School's geographical location provides unusual advantages for further development of this project. It is one of the few large institutions for the mentally retarded located within one of the country's foremost medical and behavior research centers. As such, it affords unique access to unparalleled facilities and resources for rapid and economical application of new behavior evaluation procedures in an institutional setting. New programs being initiated at Fernald School as well as a concerted effort to modernize its personnel and operating procedures make Fernald a fertile field for extensive application of behavior evaluation and modification techniques.

Laboratory facilities were designed by the Project Director specifically for the purposes of this program. Construction was funded by special legislative appropriation and by the Department of Mental Health of the Commonwealth of Massachusetts during the first year of this program (see Progress Report). Eight cinderblock conditioning chambers equipped with individual periscopic observations systems are available for our use. Five rooms are equipped with a variety of automatic programming and recording equipment purchased during our first two years of grant support. During the third year of our current support, a sixth chamber will be equipped for multi-channel behavior analysis. A partially equipped shop is maintained for construction and repair of apparatus.

Three offices are nearly completely equipped to handle the administrative, data analysis, and communication functions of the program.

A children's playroom and a classroom within the laboratory permit close coordination of laboratory-application feedback and opportunity for informal observation of the children to facilitate interpretation of laboratory findings.

The core laboratory staff consists of the Director and six assistants, all of whom have worked together to develop a smoothly coordinated program of responsibilities in carrying out the many tasks of a daily-operating laboratory.

For the purpose of supporting this project, a special budgetary item obtained institution staff salaries for the Director and one laboratory assistant. Other positions have since been added by the institution as an indication of its interest and support. A nurse does routine daily clinical examinations on each child, checks medications, and assists in recording daily behavior observations in the laboratory. In addition, we have recently recruited two new additions to our staff, both of whom have been hired by the institution in jointly affiliated roles. A Master's level teacher of the retarded, appointed by the School Department, is with the program to develop our working liaison with special education by demonstration-training of selected children. A Teaching Assistant, hired by the Nursing Department, functions as one of our staff in demonstration-training of attendant personnel directly involved with the children studied in the laboratory.

Related institutional programs will facilitate our investigative and training functions. The In-Service Nursing Education Program (MH 8840) is coordinating a substantial part of its activities with our plans for ward-training application. The emphasis of the In-Service Program on training attendants in child development principles and on changing the function of the attendant from housekeeping to child training dovetails well with our behavior-oriented evaluation and modification procedures. In collaboration with the In-Service Nursing Education, we are currently planning a behavior development program in the dormitory housing most of the severely retarded laboratory-studied children. This program will serve a dual purpose of attendant-training and of functional analysis of behavior-supporting conditions in the ward milieu.

Programs now being planned for the recently approved Fernald School Center for Research and Training in Mental Retardation will enhance the opportunities for further developing our behavior evaluation program. Rounds and case conferences conducted by senior staff members from Massachusetts General Hospital have already begun to furnish much-needed medical data on many of the children we are studying. We, in turn, are able to provide specific behavioral data as part of the diagnostic workups on children we are studying. As more accurate and comprehensive data become available on Fernald's severely retarded youngsters, we will be able to focus our methods on specific disease entities and to compare their laboratory behavior patterns with those from other children we have evaluated. With a more competent staff, we look forward to developing close collaborative relationships with specialists interested in evaluating the effects of various pharmacologic, neurosurgical, and psychotherapeutic procedures against our individual behavioral baselines.

D. Method of Procedure

Our double-barreled approach requires methods which fall into two general categories: 1) laboratory behavior evaluation and 2) field analysis and testing. Both should be developed concurrently to maximize laboratory-application feedback and to facilitate opportunity for improvement of child care and habilitation.

1.0 Laboratory Behavior Evaluation. Our methods are designed for objective measurement of reliably different individual behavior patterns among the retarded children at all levels. A number of variations are currently being tested for this purpose, and considerable development is necessary to sensitize the procedures sufficiently for predictive or prognostic purposes. In general, however, the common properties of our measuring systems consist of four components: 1) a standard controlled conditioning environment, 2) specially designed apparatus by which the child can manipulate this environment and which

simultaneously picks up selected types of non-adjustive behaviors, 3) a variety of programs which automatically control the presentation of stimuli, the delivery of reinforcements, and the response requirements necessary to obtain them, and 4) a continuous automatic recording system which separately quantifies the rates of each type of response picked up by the apparatus.

Each child is always free to behave as he wishes in the controlled chamber, and the recording and programming equipment remains active as long as he is in it. To obtain a piece of candy, a picture, the sound of music or his teacher's image or voice, he must operate the apparatus in a certain way. If the device delivers something he likes, our data show that he will operate it for long periods of time every day for months or years if given the opportunity. The child's sustained interaction with the measuring environment may reveal a variety of deficits and/or abilities. His simultaneously recorded "non-adjustive" behaviors (rocking, yelling, headbanging, etc.) may compete with or coexist with his adjustive attempts at manipulating his environment.

Our measuring devices are designed for maximum programming flexibility. Ultimately, within a given measuring environment, we will be able to present a variety of potential reinforcers on different types of schedules, both auditory and visual signals, with a variety of response requirements. Potential reinforcing agents will include both social and non-social, "live" and "canned", both visual and auditory modalities, with both familiar and novel content. Auditory and visual signals will range from simple colored lights and pure tones to complex forms, photographs, and video-taped instructions. Response requirements will range from simple movement of a limb to more complex responses emitted either singly, simultaneously, or in prescribed sequence.

By manipulating the above variables, one at a time, and permitting the child's behavior to stabilize under each condition, we are determining what kinds of reinforcement he responds for, what types of signals he is able to use, the complexity of his response repertory, and how readily he is able to shift his behavior patterns in response to either simplified or increasingly more complex requirements for reinforcement.

Since we are interested in amplifying behavioral differences among retarded children, our procedures are being developed to yield conclusions with respect to individual children. Rather than testing for average group response to selected variables, we are repeatedly measuring a number of behaviors within single subjects under different conditions to determine what set of conditions produces each child's most efficient performance.

These general design features are our methodological guides. Our laboratory evaluation during the four years of renewed support here requested will extend the applicability of our individual behavior analysis methods to the following four areas:

1.1 <u>More specific delineation of behavior deficits and abilities within severely and profoundly retarded subgroups</u>. Our analysis of discrimination and differentiation deficits, using an apparatus and program described in the literature by Barrett & Lindsley (2) and Barrett (1) will be further refined to permit more precise description within these deficit categories. Both apparatus and procedural modifications should permit us to answer some of the following questions: Is defective response differentiation (inability to tell two plungers apart) limited to a given

response class or does it generalize to other forms of response? Is it possible to produce response differentiation by simple instructions? By requiring more force to execute movements which do not pay off? By various forms of punishment (prevention of reinforcement, production of aversive sounds, taped verbal castigation by an attendant or teacher, etc.)? Does discrimination of simultaneously presented stimuli depend on the ability to tell two responses apart or are these processes independently vulnerable to deficit? Are the techniques necessary for training a child to tell two responses apart also applicable to training him in stimulus discrimination? Do discrimination deficits cross sensory modalities where acuity is presumably within normal limits? Are some apparent deficits in either response differentiation or stimulus discrimination largely due to motivational deficiency? Does the presence and/or encouragement of the child's teacher or attendant compensate for or further intensify the child's motivational problems?

As we select successively more severely retarded non-verbal children, we encounter many who are apparently unresponsive. Some of these children are thought of as vegetative and others are very active but appear to be under little environmental control ("out of contact"). Our task with these children is to explore their existing reflex components: their movement repertories as well as the antecedent and subsequent environmental stimuli associated with each form of movement. We will search for hitherto unnoticed behavior-environment interactions that can be programmed in the laboratory and used for specific training of each child. Certain components may be deficient, others may be intact but never thought to be useful for assessment or habilitative purposes.

For example, a child who does not pull plungers or push buttons for candy may move from a sitting to a standing position for candy. He thus shows a current response function deficit possibly involving the use of the hands. However, this child's behavior shows that candy is a reinforcing consequential event for another series of more complex movements that are in his repertory (moving from sitting to standing). This chain of movements could be used as a starting point for shaping other forms of response. Thus, even though he may not handle objects to manipulate his environment, he does execute other movements which can be given the function of manipulating his environment. Such a child is frequently concluded to have no discriminative ability usually because no consistent effort has been made to test it. However, if we find that this child will move from sitting to standing for candy only when the picture of one attendant is presented but not when another attendant's picture is shown, he has given us evidence of complex visual discrimination ability (as well as a lead in selecting the most appropriate attendant for this child).

Laboratory recording and programming procedures which analyze a child's behavior into simple reflex components should permit us to isolate components which are present and those which are deficient or absent in each child. In this manner we hope to extend our evaluation methods to those children not testable by other methods. Identical programming and recording procedures used throughout all methods will permit direct comparisons between individual children despite wide differences in their severity of behavioral retardation. In addition, we will be able to delineate patterns of deficits and abilities not hitherto quantified.

Once we have functionally defined those components which are present and those which are absent in a given child's behavior, we will then analyze the procedures by which deficient components may be built in and existing components may be shaped into more efficient and more effective performance patterns. (See Lindsley(3).)

1.2 Direct measurement and functional analysis of repetitive motor symptoms shown by the majority of severely retarded children. We have made a start on designing a series of transducing (pickup) devices to permit continuous measurement of both rocking and head banging, two of the most frequent forms of repetitive movements shown by our children. Considerable developmental work is necessary to produce reliable, indestructable, wireless transducers that are specific for the movements of interest. Once these symptomatic movements are directly and continuously recorded simultaneously with the child's adjustive behavior, we will then analyze the relationship between occurrences of, say, rocking and the child's ability to manipulate his environment for reinforcement. Do these symptoms coexist with or compete with the ability to form and maintain simple discriminations? How are these symptoms related to measurable environmental events which either precede or succeed them? Do identical movements serve the same function for each child? Can the rate of these movements be attenuated by appropriately selected and appropriately programmed environmental consequences? Do identical movements respond similarly to identical control techniques? To what extent do immediate environmental influences contribute to the occurrence and maintenance of repetitive motor behavior?

1.3 Analysis of the current and potentially available behavior of profoundly retarded and multiply-handicapped "crib" cases. We plan to adapt laboratory measurement techniques to permit precise assessment of behavior modifiability in children currently considered to be incapable of any purposeful motor responses. A fully automated conditioning crib will be developed by successive empirical determination of specific design features necessary to generate and sustain simple motor responses and to test for basic discriminative abilities. We will first explore the normal movement repertory of each child and the conditions which facilitate or suppress those movements for which we can design simple transducers (pickups). By programming appropriately selected movement-produced consequences, we should be able to demonstrate that certain movements can be built into functional responses and then either shaped into more complex types of responses or sustained for purpose of testing the child's ability to perform simple discriminations.

As we successively demonstrate the behavior-eliciting and/or the behavior-sustaining functions of various antecedent and movement-produced stimuli, we will test the generality of their functions with a number of different "crib" children. In this way, we hope to develop techniques for measuring individualized response patterns and discriminative abilities among these "hopeless" children. Simultaneously, we will be generating empirical data as a basis for approximating the design of a "universal" behavior-evaluating environment for crib-ridden profoundly retarded children.

1.4 Individual behavioral evaluation of other treatment and training procedures. Clinical observation suggests that some pharmacologic agents, e.g., certain anti-convulsants, sedatives, and tranquilizers, may interfere with the

adjustive behaviors of some children. We plan to explore the sensitivity of our multi-channel simultaneous recording systems for determining the effects of various drugs on both the target symptoms (e.g., hypermotility) and the child's ability to respond to and deal with his environment. We will be interested in the latency of onset, direction, magnitude, and duration of whatever drug effects are shown by our devices. In addition, we will look for individual drug-behavior interactions as possibly useful prognostic-prescriptive indices. Simultaneous measurement of symptomatic and adjustive behaviors will yield fully objective behavioral determinations of individualized maintenance dosages which maximally control the child's symptom without impairing the child's learning ability.

In a similar manner, we plan to explore the usefulness of our laboratory methods for 1) evaluating the effects of current ward care and training procedures and 2) predicting the response of individual children to new habilitative techniques based on laboratory-measured behavior. A small group of severely retarded children will be selected from among the least competent and least responsive in the dormitory where our behavior development program is being planned. (See Facilities section and Progress Report.) The current ward management of these children requires little behavior from them. All feeding, dressing, bathing, toileting, etc. is done for them, and they are considered by the dormitory staff to have "no behavior potential." Our laboratory observations of these children disclose behavior capabilities not shown on the ward (see examples in appendix). We do not yet know whether these children's behavior changes in the laboratory are due to the nature and amount of behavior required from them here as compared with the ward environment.

With children who do not manipulate the experimental environment for the programmed consequences, we will initiate a program of specific behavior management procedures on the ward (e.g., increased requirements for certain self-help behaviors demonstrated to be within each child's current or potential repertory). By following these children regularly both in the laboratory and on the ward, we will determine the effects of our ward-behavior development procedures on 1) each child's behavior on the ward and 2) the responsiveness of these children as measured in the laboratory. If any definite changes occur, we will eventually revert to ward care procedures currently in use. In this manner we will attempt to determine whether the behavior changes shown by each child are reversible or irreversible and whether the prevailing methods of ward care are reflected in the child's laboratory behavior.

On the basis of our current findings, we expect that some children in the ward-defined unresponsive group will respond at relatively high rates in the laboratory. Some will also demonstrate varieties of discrimination and differentiation not thought to be within their repertories. Guided by their laboratory profiles, we will formulate specific ward training procedures for each child in order to explore the predictive (prescriptive) value of our laboratory evaluation procedures.

2.0 Field Analysis and Testing. To complement and supplement the laboratory evaluation data, we need considerable information on 1) existing care and training conditions with respect to individual children, 2) existing ward behavior of each child, and 3) each child's response to newly initiated training procedures. Our laboratory data indicate marked behavioral individuality and considerable intra-individual variability (1,2) among retarded children. Therefore fairly long-term repeated observations and recording are required for each child to establish reliable individual profiles of ward behavior.

2.1 Development of behavior observation and recording schedules. With our team of teachers we will develop a series of behavior observation and recording schedules designed to describe in functional terms the three types of information listed above. A few children being studied in the laboratory will be continuously observed during such periods as feeding, bathing, dressing and toileting. Via a "quickie" coding system we will record specific behaviors of both attendant and child in successive short time intervals. This procedure should reveal a range of behaviors from both child and attendant. It should also clarify the temporal relationships between various actions of the child and those of the attendant. These data provide an empirical basis for constructing simple recording grids showing the functional relationships between specific behaviors of each child and specific actions of the attendant. The types of child behavior sustained by existing attendant behavior should be revealed in this manner.

2.2 Selection of individualized training procedures. Both ward and laboratory data will assist in modifying the current management practices with certain children. Thus if a child works harder for food than other types of reinforcers in the laboratory, we will begin self-feeding with him on the ward. If the same child shows he will work for solid foods, we will eliminate puréed food that is now given to all children who do not self-feed. If the child shows laboratory evidence that he uses visual cues better than auditory cues, we will explore just what his differential response is to visual versus auditory stimulation in the process of learning, say, self-feeding (or dressing, toileting, etc.). If the child's laboratory operant behavior is controlled by presentation of his own visual image, and he shows ability to discriminate his image from the image of another child, we might introduce the visual feedback of a mirror to assist him in self-dressing. If he works harder for TV than for other laboratory reinforcers, we will use access to TV on the ward as a means of requiring higher levels of behavioral competence from him.

Our teachers will familiarize themselves with each child's laboratory data and will select and supervise training procedures on the ward and in the laboratory classroom. They will also continue recording behavior observations on each child as described above. Throughout the training interval (duration determined by each child's rate of progress), we will be looking for evidence of specific abilities or deficits as shown in the laboratory. In particular we want to know whether children who do not differentiate responses in the laboratory also show this type of deficit in the classroom and the ward. The same holds for simple visual and auditory discriminations. Other dimensions such as length of attention span, rate and stability of behavioral output will also be examined in relation to the laboratory data on each child. Our teachers will set up some simple tasks designed as classroom and ward analogues of the laboratory procedures which automatically measure some of the above variables.

With parallel and simultaneous laboratory evaluation and field analysis, we will explore the relevance of our behavioral conditioning methods for describing, predicting, and habilitating retarded behavior. We will demonstrate various conditions under which the behavior of severely retarded children can be both developed and attenuated. We will test the generalizability of our laboratory findings for individualized training of hitherto untrained children. In this way, we hope to demonstrate the practical application of laboratory behavior analysis for improved training of retarded children.

References in section D (above)

(1) Barrett, B. H. Acquisition of operant differentiation and discrimination in institutionalized retarded children. Amer. J. Orthopsychiat., 1965, 35, 862-885.

(2) Barrett, B. H., & Lindsley, O. R. Deficits in acquisition of operant discrimination and differentiation shown by institutionalized retarded children. Amer. J. ment. Def., 1962, 67, 424-436.

(3) Lindsley, O. R. Direct measurement and prosthesis of retarded behavior. J. Educ., 1964, 147, 62-81.

E. Results

Our devices are designed to reveal temporal dimensions of behavior that cannot be "seen" or integrated by the human observer-recorder. Their sensitivity and reliability within fully controlled environments permit us to adapt a model for behavior analysis more akin to the "intensive" single-organism analyses of organic medicine than to the traditional "extensive" analyses so common in the behavioral sciences (1,2). We have selected the paradigm of "experimental analysis" rather than "statistical analysis" to identify pertinent individual behavior patterns upon which to base decisions about individual habilitation and treatment. Our goal is to obtain practical, habilitatively relevant information about individuals rather than statistically significant probabilities about groups of patients.

1.0 Data Analysis. In the light of these goals, we are applying certain principles in analyzing the data. First, our laboratory measuring devices directly and automatically quantify and analyze the functional relationships between behavior and recurring environmental variables. Thus, the simultaneous analysis of, say, rocking and the child's manipulation of the environment will cumulatively record the rates of these two types of behavior on two independent, continuous channels. Additional analysis by the apparatus will separate the rates of these two independently measured behaviors under each of the stimulus conditions programmed by the apparatus. Data from our ward and classroom observation schedules will be similarly analyzed into rate units, under specified conditions of teacher attendant behavior. This should facilitate comparisons between the two sets of data for given individuals.

Second, we will stay as close as possible to the automatically quantified and mathematically manipulable laboratory data. Continuous cumulative records of all behaviors picked up by our devices afford permanent visual tracings of moment-to-moment changes in rates recorded in equal response units through a constant progression of equal time units. These records as well as our observations of each child in the laboratory are continuously examined for subtle and dramatic variations in individual response rates that may reflect clinically relevant behavior correlates. With the added information from parallel behavior observations of individual children in the ward and classroom, we will look for relationships between the two bodies of data to sharpen the evaluative and predictive sensitivity of our behavior analysis methods.

Third, all data will be treated individually. The session-by-session multi-channel data for each child will be plotted day by day in parallel with his multi-dimensional ward and classroom observational data. Relations between reinforced responses and each of the nonreinforced responses will be graphed

as rate indices which enable us to compare the behavior of individual children with markedly different absolute behavior outputs. These three types of graphs will summarize each child's profile of abilities and deficits under a succession of different task or stimulus conditions.

As we probe the limits of a deficit or the child's amenability to environmental manipulation by introducing changes in the task, the stimulus "props", or the requirements for reinforcement, we will look for unequivocal "effects" for that child — effects that are striking enough to by-pass the need for statistical tests. The reliability of these effects will be tested by replications on the same child. Their generality will be determined by testing the effectiveness of each variation across tasks with the same child and by introducing the same "test" conditions with other children showing the same deficit.

Numerical criteria are being developed to group the children with respect to their behavior patterns under different environmental conditions. We will look for shifts in these functionally defined behavior groupings resulting from introduction of each new environmental variable, both in the lab and on the ward. Can we employ laboratory analysis to define subcategories of behavioral retardation for which specific environmental "props" or training conditions are necessary to maximize efficient acquisition and performance? To what extent are certain "props" necessary not only for learning but also for maintenance of learned behaviors? How are these laboratory-defined "prosthetic" props related to the most effective procedures in the classroom? What changes in laboratory procedures yield increasingly relevant results for individualized behavior description and modification?

Until we have thoroughly tested the sensitivity and reliability of our devices and predictive usefulness of our findings on individual children, it will be both premature and uneconomical to proceed with normative studies.

2.0 Communication of Methods and Results. Our current communication procedures will be further developed to include a wider range of institutional personnel, student groups and parent groups. Informal group discussions with ward personnel, formal presentations to professional institutional personnel, laboratory tours and lectures for visiting professional and student groups will increase in frequency. Distribution of preprints, reprints, and news articles will be broadened both within the institution and to all professional and non-professional individuals interested in our work. Consultation and speaking engagement requests will be filled, and presentation at professional meetings will continue. Publication of three additional articles is planned to report development of procedures, newly revealed behavior patterns and their modifiability, and the use of laboratory evaluation methods in improving the training of retarded children. Laboratory facilities and training will be made available to pre- and post-doctoral fellows and to whatever residents in various medical specialties may wish to become familiar with and further explore applications of our methods.

Our most valuable results will occur as increasingly functional interchange of information is developed between the laboratory and the teachers and attendants directly involved with the care and habilitation of our retarded children. Laboratory methods which identify and modify unrevealed abilities and deficits should assist in designing maximally efficient habilitative environments to generate and sustain the highest level of behavioral competence from even the most profoundly retarded children. The demonstrated usefulness

of laboratory analysis in habilitating behavior retardation should provide groundwork for accelerated collaboration between experimental behavior science and its application in expanding our knowledge about and in restoring behavioral dignity to all handicapped and retarded individuals.

References in section E (above)

(1) Chassan, J. B. Stochastic models of the single case as a basis of clinical research design. Behav. Sci., 1961, 6, 42-50.

(2) Chassan, J. B. Statistical inference and the single case in clinical design. J. Stud. interpers. Proc., 1960, 23, 173-184.

APPENDIX

Relevant summary and anecdotal information

The following are some illustrations of laboratory-demonstrated behavior capabilities which differ markedly from ward descriptions.

Inactive, unresponsive severely and profoundly retarded children who are responsive in the laboratory. Of the 39 new children started in the laboratory during our 17 months of operation, 12 (31%) are reported to be inactive or unresponsive by ward personnel. Only 1 of these children regularly dresses himself and is toilet trained. Of these 12 children, 8 demonstrate rates in excess of 100 Resp./hr. when working for a suitable reinforcer on a single plunger (usually at a response per reinforcement ratio of 10). These rates are sufficiently high to permit further analysis of more specific abilities and deficits. Of these 8, 2 children respond between 300-500 Resp./hr.; 2 children have rates in excess of 1000 Resp./hr.; 3 children exceed 2000 Resp./hr.; and 1 child regularly works at approximately 4500-5500 Resp./hr. All of these laboratory-responsive but ward-unresponsive children show rate differences that are determined by the nature of the available reinforcer, i.e., they discriminate between reinforcers.

Two of the 12 ward-unresponsive but laboratory-responsive children were said to be autistic. One had been admitted from a children's psychiatric residential unit; the other has a 45 decibel pure tone hearing loss attributed to neurological dysfunction. In the laboratory, neither of these children shows any of the response patterns found in autistic children. The behavior output and regularity of both children far exceed that found in all bonafide autistic or schizophrenic children studied with identical methods. The deaf child has demonstrated more rapid acquisition of response differentiation and discrimination of visual signals than most of the 65 retarded children we have studied thus far. In addition, he shows temporary disruption of visual discrimination when pure tones are combined with the light signals. This suggests that this child does "hear" pure tones but is not able to "use" them. We are currently engaged in further analysis of his discrimination abilities.

Another of the 12 ward-unresponsive children showed little responsiveness in the laboratory until a highly individualized reinforcer was found by observing her in the ward dining room. This 12-year-old girl has thick congenital cataracts, spent the greater part of her life in the institution's blind unit, and is reported to have only lightness perception. Ward personnel report that Jeanne cannot feed herself, therefore she is routinely spoon-fed puréed food by an older patient. In the laboratory, Jeanne's motor coordination was shown to be quite adequate for use of eating utensils. The first time she was left to eat on her own, Jeanne spent most of the meal looking around and occasionally moving the spoon in her bowl of gruel. Twice she deftly reached across the table to steal a glass of milk from another girl. Nothing else was ingested. We then put on Jeanne's table some potato chips which had not been given the "non-feeders." Jeanne immediately grabbed them, stuffed them in her mouth voraciously, masticated and ingested them with dispatch, and looked around for more. The following day, Jeanne's rate in the laboratory went from zero to 450 when potato chips were put in the reinforcing apparatus. (It reverted to zero with M & M candies.) Thus we quickly discovered that Jeanne can feed herself, that she is capable of masticating, that she has definite food preferences, and she has more than lightness perception. Subsequent informal experimentation demonstrated repeatedly that Jeanne's behavior can be controlled by approving and disapproving facial expressions at a distance of at least 12 ft. - a set of complex and subtle visual-social discriminations in a legally blind child said to be "unable to learn anything."

"Non-ambulatory" children who walk. Two of our children, one a 4-year-old phenylketonuric girl and the other a 16-year-old boy were said to be non-ambulatory. The young girl was routinely brought to and from the laboratory in a wheel chair. The boy was carried in by an attendant, who strapped him in his chair much the same as on the ward (presumably to avoid his falling out of the chair). There were no medical reasons for these apparent disabilities. Our procedure with such children is to remove them from wheel chairs and restraints and to encourage them to ambulate while waiting their turn in the experimental rooms. Instead of carrying or wheeling, the children are helped up and left to locomote on their own for whatever we find reinforces them. The boy had to walk to get to the "candy" room. The little girl had to stand up to reach any of the toys which are always kept on a table. Within a couple of weeks, it was no longer necessary to carry the boy, and the girl had taken her first steps. A month later she began walking back to her dormitory beside the empty wheel chair. It was clear from observing these children's ward care, that no reasons for ambulating had been provided. They were either restrained and everything was brought to them, or else they were left in an environment so barren that there was nothing to walk for.

Defecation and smearing as operants (ways of manipulating the environment). The boy mentioned above was reported to be a feces-thrower and smearer before he started in the lab over a year ago. In this respect, he is typical of a number of children who come to the lab. During the first two weeks he regularly loaded his diaper while waiting his turn in one of the experimental rooms. Our Fernald nurse responded as she had been trained for many years: she dutifully changed the diaper of this teenage young man. After 1 week, this type of attention was terminated. No diaper changing has been done in the laboratory for over a year. All children are toileted when they arrive at the lab. Within one week, the above boy stopped defecating in the lab. This was concurrent with his being reinforced for walking alone. We spoke with the ward personnel about his rapid progress and suggested they abandon the wheel chair and reinforce Steve for ambulating and helping himself. Within weeks this boy was proudly showing off his self-help skills. He no longer needed diapers. He no longer threw or smeared. Last summer, he spent an entire afternoon walking around the zoo on a trip arranged by the laboratory staff for children who were saving up their laboratory-earned penny reinforcers. He has not had an "accident" for so long that many of the staff who have been with us approximately a year did not know this was even a problem. The majority of other breeches-loaders have responded similarly. Some of the smearers have stopped this activity when access to their feces is made impossible by tightly securing their pants belts.

Use of money by "untestable" and "uneducable" children. Eleven of our 31 severely and profoundly retarded children have worked for pennies included in their reinforcer mixture. All 11 have learned to make use of their penny reinforcers. (Incidentally, so far we have had no incidents of pennies being swallowed.) The first of this group to learn use of money is a mongoloid boy who had never been exposed to any training program. Apparently by simply watching other children count and exchange their pennies for dimes to operate the coke and candy vending machines, he learned that by placing a penny under each finger, he could count ten, for which he was reinforced with a dime. This he promptly used to buy a coke. Since then he has been teaching other children to use their pennies in like manner (including some who have been in the school program for many years). On the zoo trip he made his own purchases with his own well-earned money as did all of the other children who have learned to make use of it in the lab. In view of this experience, it appears that the use of plastic tokens with children of this level is not necessary. It is also evident that these children are quite able to benefit from training in skills heretofore not thought to be within their behavioral range.

Disappearance of tantrum and disruptive behavior. When we first began working with severely retarded children, we experienced one example after another of tantrum behavior

and various forms of aggressive and destructive behavior. The staff has learned that this is not to be reinforced with attention or with access to any of the experimental rooms. For a while, we had a "tantrum" room stripped of all apparatus and ways of observing others. It was used only twice. Most children's disruptive behavior dropped out when it brought no attention and when more adjustive behavior was highly reinforced by staff approval. While many of the children now exhibit the more normal exploratory and playful behavior expected of them, their general demeanor in the laboratory has changed drastically from what it was initially. These children had never been considered for field trips. The laboratory staff now looks forward to planning as many as possible before the winter weather arrives.

Concluding comments. The above are informal observations which both complement and supplement the highly controlled laboratory experiments. They give repeated indication that the environmental response to these severely retarded children directly affects their behavior. The more specific behavior-environment functional interactions are being analyzed in the laboratory and are being summarized for journal publications. While the laboratory data, in general, corroborate our impressions from "eyeball" observations, it is reassuring to see more general signs of social progress in the children regularly followed by our automated behavior evaluation procedures. The many implications for improved diagnostic and training opportunities for children like these are sufficiently rich to warrant investigative pursuit of the more profoundly retarded children and more detailed analysis of our current group.

We are grateful for the support we have received from the National Institute of Mental Health. It has enabled us to begin exploring an area we believe to be uniquely accessible to our developing methods. We look forward hopefully to the privilege of being able to continue our work on behalf of those whose behavior, one day, will "speak" to us.