A BEHAVIOR EVALUATION PROGRAM FOR RETARDED CHILDREN

Prosposal Abstract

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A. Specific Aims

1) The problem. What are the most propitious conditions for each retarded child to attain his highest level of development? What are his unique abilities and deficits? How can we know that our services are benefitting each child? What is our evidence that a given child is being improved by any part of a given program?

Most of the training efforts in our institutions for the retarded are based on hopeful speculation rather than on established fact. One of the fundamental problems is that our techniques for evaluating the abilities and deficits of retarded children are crude enough to wash out the individual patterns and specific problem areas that may be the most significant clues to effective training. The acknowledged deficiencies of evaluative tools have encouraged increasing reliance on subjective judgment and anecdotal description. Selection of a child for a particular type of training may easily be determined by personal and theoretical biases, unrecognized stereotypes, or the implied developmental limitations of a diagnostic classification. Once rejected from a particular program, it is unlikely that the child will be reconsidered or re-evaluated as he develops. A single decision can then remain an unquestioned determinant of the child's life existence within the institution. If accepted, his training may be based on intuited needs, the "experience" of his teacher, or the methods thought to "work" best with the greatest number. The effects of his training may then be judged by whether he conforms to the expectations and desires of the staff.

What has happened to the subject of training - the behavior of retarded children? Have we tested each child's limits for more adaptive functioning? Is it possible that training and treatment programs may be more heavily determined by the beliefs and rationalizations of parents and staff than by the demonstrated needs of the children themselves? If so, are there techniques which might reverse this process in favor of the children we seek to help?

Can we provide ways for the children to show us the answers?

Technological advances have produced new methods for directly recording and analyzing a child's behavior. Experimental behavioral science has developed highly sensitive, automatic procedures for measuring and modifying the way a person responds to and deals with his environment. These methods and principles have produced complex behavior in lower animals. They have continuously analyzed the astronaut's interaction with the controls of his capsule. They are currently being applied in analyzing the deficits in severely psychotic patients, in reducing the frequency of neurogenic and psychogenic symptoms, in training autistic children, and in the development of "teaching machines" and programed instruction. The usefulness of these techniques has been demonstrated in many areas of human behavior study. However, they have yet to find broad application in the field of mental retardation, where their potential contribution may be even more substantial.

Underlying these new methods is a fundamental principle: the subject's behavior is the final criterion of effective training.

2) Specific aims. This application seeks support for development of a new behavior-oriented approach to evaluation and training in an institution for the mentally retarded. Our strategy is to apply rigorously-controlled behavioral conditioning methods to the problems of behavioral diagnosis, training, and prognosis. Fully automatic techniques will bypass both the human observer and the child's limited verbal communication. They will permit direct and continuous measurement of a child's behavior as he responds to and deals with his environment. Thus the child's behavior will speak for itself.

More specifically, we propose to initiate a program of exploratory developmental and applied investigation with the ultimate goal of providing a battery of fully objective "laboratory" procedures to supplement clinical techniques for diagnosis, prognosis, and training in mental retardation. We plan to adapt the most useful of the techniques currently employed in basic experimental research with psychotic and neurological patients and to devise new procedures specifically designed for the retarded. By further developing and adapting these techniques

to clinical problem areas and by communicating their principles and applications to a wide variety of practitioners within the field, we hope to evolve a more precise and comprehensive understanding of the retarded child. In addition to its investigative function, the "laboratory" would become an educational center for the training and stimulation of the therapeutic and caretaking personnel in our institutions and clinics for the retarded.

The initial phase of this project will have two major aims: a)precise delineation of the specific abilities and deficits of children throughout the range of retardation, and b)exploration of the environmental conditions that enable each child to learn most efficiently. We will concentrate on highlighting individually different behavior patterns and on grouping children with respect to the variables that support their best performance. Throughout this phase we will be refining and developing our procedures for broader application to a wide range of behaviors which should change under effective treatment conditions. Some of our most fruitful clues will come from close contact with the teachers, physicians, and nurses who supervise our subjects in daily life. In turn, these practitioners will learn to apply in their everyday work the principles and techniques demonstrated to be effective in a highly controlled setting.

Later phases of the work will deal with evaluating and predicting specific treatment effects on each child's ability to respond to and deal with his environment. On the basis of findings and principles generated by our methods for behavior analysis, we hope to devise new methods for on-the-ward training of multiply handicapped, severely retarded children and more effective methods for habilitating less severely retarded children.

Our broad aim is to make it possible for the clinical disciplines in the field of mental retardation to take advantage of the procedures and methods of natural science that have heretofore been considered the exclusive province of basic experimental psychology. More direct, more objective evaluative tools should diminish the necessity of speculation and subjective judgment and thus should help free mental retardation from the superstitions, untested assumptions, and biases known to be perpetuated in the absence of established fact.

B. Significance

A developing behavior-oriented evaluation program, integrated into and concerning itself with problems of patient training and care, will have general educational and service value within this and other similar institutions. In administration, type of patient population, and staffing, the Fernald School is characteristic of the majority of state schools for the retarded throughout the country. Therefore, we would expect general applicability of the findings of the proposed project. The reinforcement principles underlying our techniques are simple to explain and demonstrate to the nursing and teaching personnel, who may then try their own new ways of motivating unresponsive children. Our emphasis on manipulating the immediate consequences of a child's behavior as a means of training has been known to stimulate ward attendants to try different approaches and to look for hitherto unnoticed subtle changes in a child's responses. Daily exchange of information with various levels of institutional personnel and particular attention to making the most of what each child can do should have significant effects on the quality of patient care. In return our regular contact with the practical problems of training and care will feed back to assist us in more rapid development of increasingly relevant evaluative and training techniques.

The new procedures to be developed in this program will provide a scientifically valid basis for more definitive and more useful behavior diagnosis. Automatic, culture-free measurement techniques will furnish fully objective, accurate, unbiased information on the way each child interacts with his environment. Individual differences among children will emerge more clearly even within severely retarded groups. More precise description of individual abilities and deficits will result. Children's unique behavior patterns will no longer be "homogenized" by insensitive assessment techniques. The clinical team will have reliable, factual behavioral data to assist in fuller understanding of each child's needs, potentialities, and limitations.

In addition to static information on the levels or degrees of specific abilities and impairments, these new procedures will show how readily the child's defective behavior can be modified and the particular conditions which favor his best performance. This more functional data will furnish a basis for design of training procedures and learning environments, individually tailored to encourage and support the most efficient behavior patterns of each child. We will know how to determine the types of cues each child is able to use most effectively and how to provide motivating conditions that best sustain his efforts to deal with his environment. Information of this nature should be useful in developing more practical, objective criteria for placing children in specific training programs.

severely retarded, bed-ridden children, whose potential "conditionability" has not been objectively explored. Procedures for evaluating and modifying very simple response patterns may well show that these children are not as "hopeless" as now thought. Appropriately designed, automated training techniques may reveal untapped capacities to respond and may ease some of the nursing burden with these children.

Immediate and long-term treatment effects on individual patients can be readily evaluated by daily determinations over periods of months or years. Continuous measurement of both adjustive and symptomatic behavior will assist in selection of drugs and adjustment of maintenance dosages specific to individual behavior patterns. For example, the ideal sedative or tranquilizer dosage would be sufficient to slow down hyperactivity without also reducing the child's ability to respond to his environment. If both hyperactivity and various learning processes are simultaneously measured in the same child, the procedure will provide fully objective, rapid determination of the onset, duration, and nature of a drug's action on the target symptom as well as its side effects on the child's ability to learn.

Once designed, set up, and tested, the automatically controlled procedures can be operated by technicians without specialized training. The shortage of professional staff will no longer interfere with regular and frequent re-evaluation of institutional residents at all levels. There should be no forgotten "untestable" patients.

Techniques which faithfully measure multiple facets of a patient's behavior daily throughout the years will provide new dimensions for longitudinal study of retarded behavior. The entire course of a disease can be followed: the emergence, development, and degeneration of different behavioral processes can be charted with assurance that no "slippage" has occurred in the measuring instrument.

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 students of all ages and at all levels of retardation. In residents, staff, and programs, it is representative of most other such institutions through the country.

Fernald School's geographical location provides unusual advantages for the proposed 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.

One of the key resources for this project is the Harvard Medical School Behavior Research Laboratory, located across the road at Metropolitan State Hospital and directed by Dr. Ogden R. Lindsley. For ten years Dr. Lindsley has been developing automatic devices to analyze behavior deficits in severely disturbed and destructive psychotic patients. Unlike other more fragile devices, they are uniquely adaptable for studying the behavior of retarded children. Dr. Lindsley's affiliation with Dr. Barrett and his enthusiastic support of this project since its early inception will enable it to move faster at Fernald than in other institutional locations. Immediate access to the new techniques being developed by Lindsley will greatly expedite their adaptation for use with retarded children. In addition, ten years of data on psychotic behavior deficits will be continually available for comparison purposes.

The Joseph P. Kennedy, Jr., Memorial Laboratories for the study of mental retardation, recently established in the Neurology Department of Massachusetts General Hospital, plans to coordinate the research activities at Fernald School with its program of basic laboratory investigation into nervous system functions. Through its developing affiliation with the Kennedy Laboratories, Fernald School will have top-level neurologists and behavioral scientists available for consultation. Dr Murray Sidman is developing new techniques for experimental analysis of specific sensory disorders associated with discrete neurological dysfunction. Dr. James G. Holland is developing self-instructional methods to synthesize specific abilities in children with focal and diffuse neurological disorders. Some of Dr. Holland's work is already in progress at Fernald. Dr. Barrett's close communication with Drs. Sidman and Holland during the past two years has paved the way for eventual collateral study of selected children using the new techniques they are developing for highly specialized basic research with less severely retarded children.

With this unusual constellation of facilities, children with known histories may be studied with a battery of distinctly different though related behavioral techniques. Through the collaborative efforts of a number of investigators working on different facets of the same

more rapidly and development of increasingly useful methods should proceed more economically than would be possible in isolation from this active scientific community.

Highly desirable space at the Fernald School has been allocated to this project. Two offices and shop are being constructed and will be partially equipped through donations from the Fernald Parents League and the Massachusetts Association for Retarded Children. We plan to provide three specially designed conditioning enclosures and a central apparatus control area for the initial phase of the proposed work and to add others as future needs arise. The space is adequate for a variety of expansion needs, including an experimental classroom and work space for students.

The location of this project in a modern building housing 300 blind and multiply handicapped "crib" cases, classrooms, physical and occupational therapy units, and manual training facilities within an institution providing a wide range of clinical cases available for daily, prolonged study literally surrounds the project with the types of challenging problems it seeks to study in a controlled setting.

D. Method of Procedure

The initial concern of this project will be the objective measurement of reliably different, individual patterns of behavior among a wide range of retarded children. While a number of methodological variations will be developed in the course of this work, the common properties of our measuring instruments will consist of the following four components: 1) a controlled environment or standard conditioning enclosure, 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.

At all times the child will be free to do as he pleases within the controlled environment, and our recording equipment will remain active as long as he is in it. However, in order to obtain a piece of candy or to produce a picture or perhaps the sound of his teacher's voice, he must operate the apparatus in a certain way. Our devices will be built to give him something he likes every time he meets our response requirement. For this reason he will continue to operate them for long periods of time every day for months or years if given the chance. Each device will be programed so that a number of different response patterns can operate it but others will not. In other words, there will be a number of available solutions to each problem. However, only the most efficient patterns will produce the greatest "payoff". These will require the child to form discriminations between the stimuli and the response possibilities that the apparatus presents.

We will permit a child to work on a given device for a number of successive sessions until he reaches his own stable pattern of operation. His behavior may be so inefficient as to reveal a severe deficit; it may be as efficient as that of a normal child; or anywhere on the broad continuum between these two extremes. We will seek to develop instruments that are sensitive enough to reveal a wide array of individually different behavior patterns from each child after a series of opportunities to operate a given device. In the process, our continuous recording system and data analysis system will reveal both the moment-to-moment changes and the overall trends in each child's adjustment to the automatically controlled environment.

Once we have isolated and objectively defined specific patterns of adjustive and defective behavior in each child, we will determine the necessary environmental conditions which enable each child to respond most efficiently. Our measuring devices will be designed for maximum flexibility in programing, so we may present a variety of different reinforcers (social and non-social) on a number of different schedules, both auditory and visual cues (from simple colored lights or pure tones to complex forms and printed or taped verbal instructions), with a variety of response requirements (from simple movement of a limb to executing a succession of different responses in prescribed sequence).

By manipulating the above variables, one at a time, and permitting the child's behavior to stabilize under each condition, we can determine what kinds of reinforcement make him most responsive, what types of cues he is best able to make use of (which stimuli he discriminates best), how complex his response repertory is, and how readily he is able to shift his behavior patterns in response to either simplified or increasingly more complex requirements for reinforcement. In this way, we will study the effects of some basic variables traditionally used

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[illegible] we will repeatedly measure a number of behaviors within single subjects under each condition to determine what set of conditions produces each subject's best performance.

Previous work has clearly demonstrated that these procedures are reliable enough so that we may make conclusive statements about individual children. It is this property of the techniques that makes them uniquely suited to the trouble-shooting of clinical problem areas.

As a specific point of departure we will start with a technique for locating deficits in two very simple abilities which underlie more complex forms of learning and adjustive behavior: telling two responses apart (response differentiation) and telling two stimuli apart (stimulus discrimination). The method was designed by Lindsley (3) to analyze deficits in severely psychotic patients and was demonstrated by the program director (2) to be sensitive to a number of deficits in retarded children. The device measures response differentiation by presenting the child with two plungers, only one of which will automatically produce a candy or penny (reinforcement) immediately after it has been pulled, say, ten times. When the child learns to respond at high rates on the reinforcing plunger and stops pulling the plunger that never produces candy, he has differentiated these two responses. Simultaneously, the process of visual stimulus discrimination is measured by presenting two lights which automatically alternate positions. One of the lights signals that candy can be obtained by pulling the "payoff" plunger. When the child learns to pull the reinforcing plunger at high rates only under the light condition correlated with reinforcement, he has shown that he has both differentiated the two responses and discriminated between the two lights. If he pulls both plungers undifferentially only when the "correct" light is on, he has discriminated between the lights but he has not differentiated the responses. If he pulls only the payoff plunger regardless of which light is on, he has differentiated the responses but he has not formed a discrimination between the two lights.

The two available responses are automatically recorded by counters and timers, and are separately and continuously recorded on cumulative recorders in a manner which measures the relationship between the child's responses and the occurrence of the light signals. Reductions in the rates of the non-reinforced response combinations relative to the reinforced combination define the formation of response differentiation and stimulus discrimination. General motivational level is measured by the total number of responses per session. Fluctuations in attention are shown by the number and duration of pauses in responding and by temporary increases in responding under the "wrong" light. A series of measures relate to emotional stability: high variability from session to session in overall response rate, high variability in the relationships between rates on each of the four response-light combinations, and the number and severity of abrupt disruptions in conditioned behavior patterns. Flexibility in shifting behavior patterns is evaluated by changing the stimulus-response combination that produces reinforcements.

More complex behavior will be tested by adding other response possibilities and by use of increasingly complex visual cues. Auditory cues will be substituted or combined with visual cues depending on the child's ability to handle the initial visual discrimination problem. Motivational problems will be evaluated by substituting other forms of reinforcement and by adjusting the schedule of reinforcement. Various forms of hypermotility that may accompany or interfere with a child's operation of the device will be measured simultaneously with the child's discrimination by pressure-sensitive mats on the floor (3) and by transistorized pick-ups which the child will wear. By automatically withholding reinforcements on each occurrence of the child's symptom as he works the machine, we will attempt to control the behavior which might exclude him from the classroom or create management problems on the ward (1). With simultaneous records of his relevant behaviors, both adjustive and symptomatic, we will be able to observe their interaction directly.

If environmental manipulation is unsuccessful in producing a change in the child's behavior, our measuring device will be used to evaluate the effects of other treatments, e.g., drugs, psychotherapy, neurosurgery. The duration and frequency of each child's sessions will be determined empirically by starting with a one-hour period each day and observing what information might be gained or lost by shorter, longer, or less frequent sessions. (Perseverance at the task will likely be a significant index in differentiating among retarded children.)

By developing a series of devices, each of which poses different types of problems that

will attempt to pinpoint specific deficits or syndromes of deficits in discrimination, motivation, attention, and social behavior. Those children showing similar deficits in the conditioning environment will be treated with identical procedures to evaluate the generality of their application. From the array of patterns shown by individual children on a succession of different procedures, we will make predictions about other subjects showing the same patterns. Future plans include 1)formulation and evaluation of training procedures, based on our findings, to be used on the wards and in classrooms, 2)formal correlational studies of conditioning patterns and ward, classroom, and workshop behavior and 3)distillation of the essential ingredients from our techniques for incorporation into a battery of highly definitive evaluation and prognostic devices.

We will intensively evaluate approximately fifty children in the course of two and a half years of daily operation with two conditioning setups. This conservative estimate is based on one-hour daily sessions for each child and data from the program director's previous work with retarded children. The exact number of subjects to be studied will depend on what we find to be the most appropriate frequency and duration of sessions and how long each child takes to achieve a stable pattern on each "test" procedure.

Selection of subjects will encompass a broad range of cases representing a variety of ages, diagnoses, handicaps, and general levels of retardation. Staff physicians, teachers, ward matrons and nurses will be asked to suggest particularly baffling or problematic children. We will also be interested in children already studied both successfully and unsuccessfully by other behavioral conditioning techniques, notably those of Holland and Sidman as previously mentioned. Children selected by the Fernald staff for specific therapies will be included, and for comparison purposes, some children rejected from these programs will also be studied. Until we have adapted the techniques for broader application, all subjects will be ambulatory. To check on the "normal" response to our developing procedures, we will include approximately a dozen children from the community at appropriate age levels.

References in section D (above)

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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.

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E. Results

In general, our methods for analyzing data are determined by the questions we ask of the data. These questions, in turn, emerge from the unfolding behavior of each child as we observe him with the aid of our automatic devices. The devices are designed to reveal what the human observer cannot "see" or integrate. In this sense, they are analogous to microscopes or to a series of oscilloscopes simultaneously "focused" on multiple aspects of the behavior of a single child. Highly sensitive "behavioral microscopes" and rigorous environment control permit us to adapt a model for behavior analysis that is more akin to the "intensive" single-organism analyses of organic medicine than to the traditional "extensive" analyses most often used in the behavioral sciences (1,2,3). We have purposely chosen the paradigm of "experimental analysis" rather than "statistical analysis" because we wish to identify pertinent individual behavior characteristics upon which to base decisions about individual treatment. Thus our questions and our methods for analysis are dictated by our goal of obtaining practical, clinically significant information about individual patients rather than statistically significant probability statements about groups of patients.

Detailed methods for analyzing our data will be evolved as we perfect new "microscopes" trained on new aspects of behavior. There are certain principles we will apply and some specific techniques which may serve as illustrative examples. First, our measuring devices will be designed to perform automatically the most exacting and tedious operations in data analysis. Functional relationships between behavior and recurring environmental variables will be directly analyzed and quantified by the apparatus. For example, in the case of the discrimination situation described earlier, where each of two responses can occur under each of two light conditions, the apparatus and recording system will automatically separate the occurrences of response A under light 1, response B under light 1, response A under light 2, and response B under light 2.

each of these behavior-environment relationships will be separately counted, timed, and continuously recorded. This method of analysis enables us to directly observe the interaction of these behavioral processes throughout the course of any "testing" session.

As a second principle, we will stay as close as possible to our raw data which are automatically quantified, highly sensitive, and mathematically manipulable. The farther we stray from these data, the more we lose of the fine "resolution power" of our original measurements. Continuous cumulative records of all behaviors picked up by our devices afford permanent, direct, visual tracings of moment-to-moment changes in rates recorded in equal response units, through a constant progression of equal time units. These baselines of different ongoing response rates from each child will be continuously examined as they emerge during each daily session. We will look for both subtle and dramatic spontaneous variations in response rates which may reflect clinically significant behavior characteristics. (An example of abrupt, severe loss of previously learned behavior is described on pp. 430-431 of the accompanying Barrett & Lindsley reprint.) Phenomena such as this may either lead to new methodological refinements or may, in their own right, define specific deficits. Clinical observations of each child's daily behavior within the conditioning enclosure will be reviewed in search of clues for development of increasingly relevant behavioral measurements and suggested clinical correlates of the automatically recorded response patterns.

Third, all data will be treated individually in this exploratory, developmental phase of the project. In addition to the individual cumulative records and individual clinical observations for each session, we will summarize each child's daily sessions in a series of graphs depicting 1)the number of responses per session for each type of behavior we are recording, 2)the number and sum of the inter-response times (pauses) in each of these ongoing behaviors, and 3)relations between the reinforced response and each of the unreinforced responses. The latter will be quantified by ratio indices (see appendix A) which enable us to compare the behavior of children whose absolute response rates are markedly different. These three types of graphs will summarize each child's profile of abilities and deficits under a succession of task conditions.

As we probe the limits of a deficit or the child's amenability to environmental manipulation by introducing changes in the task requirements, the environmental supports, or the reinforcement, we will look for unequivocal "effects" for that child. The effects of interest will be striking enough to bypass the need for statistical tests. The onset, duration, and magnitude of these effects will eventually be represented numerically after we have tested their reliability by replications on the same child and their generality by introducing the same "test" conditions with other children showing the same deficit. (Examples of replicated "schedule" effects on the discrimination of a retarded child and on the control of multiple tics are given on pp. 433-434 of the accompanying Barrett & Lindsley article and on pp. 192-193 of the accompanying "tic" article by Barrett.)

From the quantified data we will develop empirically determined numerical criteria or "cut-off" points by which to group our subjects with respect to their behavior patterns under different environmental conditions. We will be interested in how the behavior of these children regroups as a result of each new environmental variable. Are there specific subcategories, defined by controlled analysis, for which specific types of environmental "props" are necessary to maximize efficient performance? Are there patterns of relationships between initial states and final states under given conditions which might be developed into predictive indices? How do these patterns differ from those of "normal" children? What are the relationships between behavior patterns revealed by our measuring and analysis procedures and the behavior of the same children on the ward and in the classroom? How are our findings on each child related to his scores on psychometric tests? What are the effects of selected treatments (pharmacologic, psychotherapeutic) on the conditioned behavior of our subjects? How effective are our findings in helping to devise specific training procedures for each child?

These questions will be answered in the later phases of this work. Until we have thoroughly assessed the usefulness of our "laboratory-based" conclusions on individual children, it will be both premature and uneconomical to proceed with normative studies.

As we refine and further develop our measurement and analysis techniques to cover a broader scope of pertinent behaviors, we will hold frequent informal conferences with teachers, physicians, and attendants to search for observed daily behavior patterns that may be correlated with patterns shown in the laboratory and to discuss how our findings on each child might be applied to improve his training and care.

In the second [illegible], [illegible] articles will be published reporting development of procedures, newly revealed behavior characteristics, their response to environmental manipulation, and the effectiveness of new behavioral evaluation methods in improving the training of retarded children. Prior to submission for publication, each of these summaries as well as less formal progress reports will be given at professional and scientific meetings.

Of far greater importance for the future integration of this developmental and applied research program into the structure and functioning of the institution will be frequent informal reports of new findings and discussion of their implications at meetings of the professional and training staffs of Fernald School as well as the continuing exchange of information between the laboratory and the institutional personnel which was begun two years ago. The ultimate validation of our methods and findings will be in their application by practitioners. Nurturing a growing involvement of institutional personnel in the work of this project will facilitate immediate on-the-ward application of the findings and principles generated in the "laboratory." In this way, we will consolidate a mutually enhancing relationship that will expand our knowledge of retarded behavior and improve our methods of identifying and maximizing each child's most promising potentialities for achieving his highest level of adjustive behavior.

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