Single Subject Research Strategies in Occupational Therapy,

Part 1

(research methods, case study)

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This paper is designed to orient occupational therapists to the use of single subject methodology as a viable mode of clinical research. The role of single subject designs in today's scientific world is explored through an historical perspective, and major strengths and weaknesses are discussed. Basic methodological concepts and research designs are presented to provide a foundation for therapists interested in documenting intervention results. Finally, some of the problems inherent in transferring single subject strategies to occupational therapy are presented.

As the profession of occupational therapy develops and adapts to an ever-changing and increasingly sophisticated world, therapists have recognized the need to document the unique contributions occupational therapy has to offer. Many authors have discussed the need for research in order to facilitate 1. the development of a philosophical base, 2. quality assurance, 3. accountability, and 4. cost effectiveness (1-5).

Recent efforts have been directed toward adaptation of traditional research models to methods suitable for the clinician with limited resources. In this search, therapists have begun to focus on the intensive study of the individual client through the use of single subject research.

The purpose of this paper is to expose the reader to single subject research as a viable method of documenting treatment results. Part 1 will provide an overview of historical development, present strengths and weaknesses, and basic methodological concepts. Part 2, to be published in a subsequent issue, will explore the use of single subject research with various therapeutic approaches.

Single subject research should not be confused with the traditional case study method. The case study is a subjective description of an individual's behavior, frequently longitudinal in nature. The anecdotal case study can be useful in providing impetus for further study or for the generation of theoretical hypotheses. However, because the case study lacks variable controls and systematic data collection, it cannot document causal relationships between intervention and changes in behavior. The case study, no matter how detailed, is not the same as the controlled single subject design. Single subject research demands

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careful control of variables, clearly delineated and reliable data collection, and the introduction and manipulation of only one intervention at a time.

**Historical Perspectives**

To understand the place single subject research holds in today's scientific world and some of the controversy surrounding its use, it is important to look at the historical development of the focus on the individual. In the late 1800s and early 1900s, intensive case studies were the accepted method of research in psychology and physiology. These studies were descriptive in nature with little control of intervening variables. As a result, clinicians frequently made extraordinary and poorly substantiated claims about the effectiveness of therapy. The descriptive case study method remained the primary mode of research during the first half of the 20th century.

The early 1900s also saw several innovations that provided the foundation for development of the group comparison method. The concept of the average person who was representative of a population was introduced. An individual's responses in testing or behaviors could then be compared to this mythical average person and individual differences explored through the use of the normal curve. These studies led to the invention of inferential statistical procedures.

By the late 1940s, clinical psychologists with skills in basic research began using the group comparison method in applied settings. The resulting emphasis on averages and generalizations effectively discredited the case study method and its exuberant claims for a period of time.

During the 1950s and '60s, psychologists and psychiatrists attempted to use between-group comparison designs to document the effectiveness of psychotherapy. Researchers soon discovered that the use of group comparison in clinical research posed several difficulties. Comparisons between treatment and control groups frequently demonstrated little or no benefit from treatment. The gains made by one person were cancelled out by the deterioration of another. The results were therefore of minimal value to those in practice. Other deterrents included the practical issues of time, expense, and feasibility of assembling a homogeneous group of subjects, as well as the ethical questions of withholding treatment from the control group.

As a result, the late 1960s and '70s have seen a renewed interest in the individual. Focus is now being directed to ideographic studies that provide detailed information about an individual's responses to intervention. Researchers have directed attention to the development of methods for studying a single case in which the variables could be controlled, data carefully collected, and the intervention approach systematically manipulated. The result has been the development of single subject research methodology, through which causal relationships can be identified (7-14).

**Strengths of Single Subject Research**

Single subject methodology offers occupational therapists a research method appropriate for clinical use. The intensive study of an individual is well suited to a heterogeneous population. The clients served by occupational therapists frequently display a complex constellation of strengths and weaknesses, which demand individualized therapeutic approaches. Single subject research offers the opportunity for in-depth exploration and documentation of the responses of a specific client, under specific conditions, to a therapeutic approach.

A unique and exciting aspect of single subject research design is the opportunity to change approaches if intervention is unsuccessful (12, 15). If the initial therapeutic approach yields poor results, that intervention can be treated as baseline behavior, and a new treatment can be introduced. The value of this approach is the identification of client characteristics that may contribute to the success of a therapeutic regime, as well as to the development of strategies for effective program change when therapy is unsuccessful.

Single subject research is valuable to the practicing clinician because it offers practical information about how a particular client responded to explicitly delineated intervention. This knowledge can be far more useful than information about how the mythical average client responded in a group study. Frequently, comparative group studies provide few criteria to help clinicians determine whether their client is likely to perform similarly to those who progressed or to those who regressed under the regime.

An additional attractive aspect of single case design is the realistic financial and temporal demands. Through careful documentation of a client's responses to a single therapeutic approach or treatment package, research may be incorporated into a clinical program. Single subject research can be conducted with minimal financial overhead, unless sophisticated electronic equipment,
useful for data collection in some studies, is required. The need for elaborate statistical procedures may be reduced when focus is placed on clinical rather than on statistical significance (12, 16). Clinical significance is a readily observable fact, demonstrated when gains made in therapy involve a positive change in the individual's life. It is possible to achieve statistical significance without achieving clinical significance. For example, in a therapeutic regime designed to reduce head banging behavior, statistical significance may be achieved when the client’s head banging behavior drops by 10 percent. Clinically this is not significant since the potential for injury continues to be very real. Statistical procedures have been developed for single subject research that may prove useful in certain situations (17).

Weaknesses
The most often cited weakness in single subject research is the lack of generalizability. What meaning do the results of one case carry for the rest of the population? Researchers cannot indicate that any other individual might respond in the same manner based on an N = 1. However, because the case is carefully described and documented, it is known that an individual with specific characteristics responded in a certain way to one type of intervention. The key to generalizability then, becomes replication. The single study must be duplicated with other clients, by other therapists, and in other settings. It is this replication that lends single subject research its power. When the causal relationship between a therapeutic technique and the improvement of individuals with a particular dysfunction can be documented across the variables of individual differences, setting, and therapist, the potential of that approach becomes well substantiated (7, 12, 18).

A potential problem in single case research is experimental mortality. When the research population consists of one person and that person moves, becomes ill, or withdraws from therapy, the project is terminated. Additional problems may derive from therapist bias in data collection and interpretation. An essential component of occupational therapy is the use of self as a therapeutic medium. That investment often brings a closeness to the client that makes maintaining objectivity difficult.

Methodology
A-B Designs. The keys to single subject research are using the individual as his or her own control and the introduction of only one variable at a time. The elemental design, upon which others are built, is the A-B design, where A represents the baseline and B the intervention. During the baseline period, A, systematic measurements of target behaviors are gathered, providing a control to which responses during the intervention phase, B, can be compared.

For example, suppose Snoopy decides that he is tired of Charlie Brown’s behavior of bringing his supper late. He collects data for a month on the number of times each week that supper arrives on time. This gives him a clear idea of Charlie Brown’s current, or baseline, behavior, which is designated as A. He decides to reinforce Charlie Brown’s behavior by praising him when dinner arrives by six. This intervention period, designated as B, appears successful because dinner begins to arrive on time. Snoopy realizes that it is important to recognize unidentified variables that may be influencing his results. For example, Charlie Brown’s mother may have begun giving him an allowance whenever he fed Snoopy on time. Since Snoopy is an intelligent dog, he employs a withdrawal design, A-B-A, whereby the intervention is terminated. As Snoopy expected, without reinforcement Charlie Brown returns to his old behavior and Snoopy is frequently hungry. Snoopy astutely assesses the situation and decides to use a reinstatement design, A-B-A-B, whereby the intervention is reinstated. When Snoopy begins reinforcing Charlie Brown’s behavior again, his suppers once more arrive on time.

Multiple Baseline Designs. The use of a multiple baseline is an adaptation of the A-B model, which provides greater flexibility. Multiple baseline designs fall into three
categories: across behaviors; across clients; and across settings. Multiple baseline methodology consists of a series of separate A-B designs with the intervention sequentially introduced across a systematic time period. In the first category, multiple baseline across behaviors, the treatment is sequentially applied to separate and, it is hoped, independent behaviors. In the second category, across clients, the intervention is sequentially applied to the same target behaviors in different clients. The third category, across settings, requires the sequential introduction of the intervention variable to one client in different locations, such as the clinic, school, and home.

Using the previous example, suppose that Snoopy decides to explore the effectiveness of social reinforcement on Charlie Brown's behavior by systematically reinforcing him for what appears to be functionally independent behaviors. He decides that, in addition to supper arriving on time, he would also like his fur brushed and Woodstock's birdbath filled with water every day. He develops a multiple baseline design across behaviors and collects baseline data on all behaviors for one month. Each week he records the number of times the target behavior has occurred. He then introduces social reinforcement for each desired behavior in a sequential manner. Snoopy charts his results on a graph, discovering that each behavior only increased when intervention was applied directly to it. The stability of each baseline behavior supports the causal relationship between the introduction of the independent variable (reinforcement) and the subsequent change in the dependent variable (Charlie Brown's behavior).

**Combined Designs.** A single subject methodology rarely described in the literature is the combined design in which the effectiveness of a treatment package is evaluated. In this case, the total package becomes B and is treated as a single, independent variable. Considering the complexity of many occupational therapy intervention programs, the combined design offers an attractive alternative to the manipulation of a single treatment approach. Unfortunately, the combined design does not indicate which components of the treatment package are critical in effecting change. In order to explore the individual components of the treatment package, an additive approach can be used in which each component is sequentially introduced and then individually withdrawn in reverse order. This would be denoted as A, B, B & C, B & C & D, B & C, B, A, with A representing baseline behavior and B, C, and D representing the first, second, and third independent variable being introduced (19).

**Basic Principles in Single Case Design**

There are a variety of other complex designs that can be used in single subject research, including reversal, multiple schedule designs, and changing criterion (6, 7, 12). The development and use of designs suitable for specialized needs is probably limited only by the investigator's knowledge of scientific inquiry methods and ingenuity. Three...
basic principles most important in single subject methodology are: careful baseline collection, use of repeated measurements, and manipulation of a single independent variable at any given time (12, 15).

**Baseline Selection.** The selection of an appropriate baseline behavior that demonstrates minimal variability is critical to the success of single subject research. If the baseline behavior never achieves stability, any correlation between the introduction of intervention and any subsequent changes in behavior becomes difficult to document. The length of baseline collection will vary depending on stability of the behavior, condition of the client, and constraints of the facility. Behavioral researchers frequently recommend a baseline equal to the length of intervention in order to strengthen research results and countermand maturational effects (6, 12).

**Repeated Measurements.** Human behavior continuously varies in response to numerous internal and external forces. In order to examine variability during baseline and intervention phases, multiple measurements must be taken repeatedly. The operations involved in data collection must be clearly specified, observable, and replicable. Precise definitions of measurement operations serve a twofold purpose: they provide a foundation for replication, and they establish inter-rater reliability.

When the operations involved in collecting data are explicitly delineated, the probability of replication is increased. Other clinicians must understand the exact procedures involved in order to document therapeutic results of the same treatment regime. The key to generalization is this replication.

This detailed description of measurement techniques is also needed in order to establish inter-rater reliability: all persons collecting data must observe and record the same behavioral parameters. A critical factor to remember in establishing reliability of data collection is that observers may be reliable—that is, concur about the presence of a behavior or characteristic—but they may be inaccurate in their findings. Remember the multitude of people who once looked out on the earth's horizon and agreed that the world was flat: reliable but inaccurate!

**Manipulation of a Single Variable.** A third key strategy in single subject research is the manipulation of one independent variable or package of variables, a process described above in the discussion of various research models. This concept is central to single case design and lends it its power. By controlling other variables and manipulating only one intervention, the potential for identifying that strategy as the change agent is greatly increased. If two treatments are introduced at the same time, it will be impossible to determine which one has precipitated any subsequent behavioral change.

**Discussion**

Single subject research techniques were developed in part to meet the demands of behavioral psychology. The transfer of these techniques to occupational therapy presents several difficulties. A baseline equal to the length of intervention provides a powerful tool for the behaviorist; however, it is not practical for many occupational therapy approaches.

To collect baseline data on the child with cerebral palsy equal to the length of intervention is unrealistic and probably not necessary. It seems reasonable for occupational therapy researchers to begin adapting single case strategies to occupational therapy’s special needs. An extensive baseline is probably not required for many chronic or permanently disabled clients.

Selecting target behaviors and realistic measurement techniques can be more frustrating. Occupational therapy intervention may contribute to changes in a diverse constellation of behaviors. Because data on the effects of various treatment approaches are limited, it may be difficult to predict precisely which behaviors will be affected.

One dilemma facing the applied researcher is whether to collect data on observable, immediate responses to therapy or on changes in occupational performance skills, which may be indirectly attributed to the intervention. For instance, should data be collected on improved midline orientation in response to handling or upon the child's spontaneous use of two hands in playing or dressing? A method of coping with this dilemma is simultaneous collection of data on a variety of behaviors. Although this approach can provide valuable input about the specific effects of a particular intervention, a multiplicity of data can be time consuming to collect and analyze.

The measurement technique(s) chosen must be specific enough to reflect subtle changes. Occupational therapists must develop objective methods to document the effects of intervention rather than rely on subjective descriptors of behavior, which may be difficult to interpret.

To control for behavior variability, the measurement technique selected must be repeatable over time. The data collection method must...
therefore be relatively free from the effects of learning or splinter skill development. Also, an efficient technique is necessary to ensure realistic demands on time and energy as the collection method is repeated.

The use of a multiple baseline design precludes treatment that creates generalization across situations or behaviors (20). Multiple baseline requires baseline stability of behaviors that are not receiving direct intervention. This requirement many preclude the use of this design for many programs where generalization of behavior is the goal. For example, when the objective for a post-CVA client is the spontaneous use of the affected arm in functional activities, generalization to a variety of activities is desired. If the therapist had to elicit the spontaneous use in each new activity, the effectiveness of intervention would be questioned.

Another significant difficulty in transferring single case design to occupational therapy is the frequent use of a withdrawal design to document a specific intervention as the change agent. Occupational therapy intervention frequently involves treatment techniques that are irreversible. When vestibular stimulation is used to facilitate integration of that sensory input and a result is increased postrotary nystagmus, subsequent withdrawal of that stimulation is not expected to produce a return to baseline levels.

Although these problems are not insurmountable, they do demand some rethinking on the part of therapists. Precise delineation of therapy goals and corresponding data collection methods must be developed. Careful documentation of client responses to intervention must become an integral part of the clinician's repertoire. Efficient, reliable measurement techniques that can be repeated over time need to be developed. Individuals with skills in both clinical practice and research will need to devote energies to adapting single subject strategies to the needs of occupational therapy. The foundations have been laid, the challenge remains to be met.

Summary
An overview of single subject research, including historical development, strengths and weaknesses, and basic methodological concepts has been presented. Some of the challenges inherent in transferring single subject methodology to the research needs of occupational therapy were discussed.

It is hoped that by using this foundation occupational therapists will begin careful documentation of individuals' responses to treatment. Single subject case methodology becomes exciting when used as an active component of a clinical program. Part 2 of this paper will explore the practical issues of implementing single subject research using various therapeutic approaches.

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REFERENCES