Single Subject Research Methodology in Behavioral Sciences

David L. Gast

ROUTLEDGE

Single Subject Research Methodology in Behavioral Sciences

This book is written for student researchers, practitioners, and university faculty who are interested in answering applied research questions and objectively evaluating educational and clinical practices. The basic tenet of single subject research methodology is that the individual is of primary importance and that each individual study participant serves as his or her own control. It is because of this focus on the individual that clinicians and educators have been using single subject research designs for over 40 years to answer applied research questions. Although the methodology has its roots in behavioral psychology and applied behavioral analysis, it has been used by applied researchers across a variety of disciplines such as special education, speech and communication sciences, language and literacy, therapeutic recreation, occupational therapy, and social work. Key features include the following. . .

- Applied Focus—More than any other text, this book focuses on the nuts and bolts of how to use single subject research in constructing one's research project or in evaluating one's professional practice.
- Numerous and Varied Examples—The book abounds in examples from special education and other disciplines and populations within the applied research literature.
- Reader Friendly—The text is written in a reader friendly style, features sample data sheets and graphic displays, and includes detailed guidelines for conducting visual analysis of graphic data.
- Expertise—The author's long and distinguished career in teaching single subject research is augmented in this book by contributions from other experts in the field.

David L. Gast (Ph.D. University of Kansas) is Professor of Special Education in the Department of Communication Sciences and Special Education at the University of Georgia. Co-author with Dr. James Tawney of *Single-Subject Research in Special Education*, he has also authored or co-authored 10 chapters and over 100 journal articles. Dr. Gast serves as a consulting editor for *Focus on Autism and Other Developmental Disabilities*, *Education and Training in Developmental Disabilities*, and *Exceptionality*.

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Contents

Preface xiii
Acknowledgments xvii

1 Applied Research in Education and Behavioral Sciences 1
DAVID L. GAST
Evidence-Based Practice and the Scientific Method
General Guidelines for Evaluating Supportive Evidence
Dissemination of Evidence-Based Practices in Education
Research Approaches in the Behavioral Sciences
Experimental, Quasi-Experimental, and Correlational Designs
Group Research Approach
Qualitative Research Approaches
Single Subject Research Approach
Research Approaches and Generalization to the Individual
Group Research Approach
Qualitative Research Approaches
Single Subject Design Approach
Summary

2 Scientific Research in Educational and Clinical Settings 20
DAVID L. GAST and JAMES W. TAWNEY
The Goal of Science
The Goal of Education and Clinical Practice
Integrating Science into Educational and Clinical Practice
Advancement of Science
Advancement of Educational and Clinical Practice
Empirical Verification of Behavior Change
Challenges of Applied Research in Community Environments
Obtaining Resources for Classroom Research
The Pragmatics of Applied Research
Teachers and Therapists as Applied Researchers
Similarities Between Research and Practice

Some Differences Between Research and Practice
Summary

3 Ethical Principles and Practices 32
LINDA MECHLING and DAVID L. GAST
Common Ethical Concerns
Core Ethical Values
Conducting Research in Applied Settings
Recruiting Support and Participation
Common Courtesies
Recognition and Reinforcement of Participation
Securing Institutional and Agency Approval
Increasing the Probability of Approval
Special Populations
Potential Risk
Defining the Methods and Procedures
General Considerations
Expertise of the Researcher
Publication Ethics and Reporting of Results
Publication Credit: Authorship
Reporting of Results
Ethical Practice
Summary

4 Writing Tasks: Literature Reviews, Research Proposals, and Final Reports 57
MARK WOLERY and KATHLEEN LYNNE LANE
Reviewing the Literature
Process for Conducting Literature Review
Selecting and Stating Research Questions
Finding Research Topics and Research Questions
Asking Research Questions Rather than Testing Hypotheses
Stating Research Questions
Summary
Writing a Research Proposal
Abstract
Introduction
Method
Data-Analysis Procedures
Writing a Final Report
Introduction
Method
Results
Discussion
Dissemination of Research
Deciding Authorship
Poster Presentations

Conference Seminar Presentation
Web-Based Publishing
Refereed (Peer-Reviewed) Journals
Summary

5 General Factors in Measurement and Evaluation 91
DAVID L. GAST
Applied Behavior Analysis
Characteristics of Measurement and Evaluation
Measurement
Identifying What Is to Be Measured
Defining What Is to Be Measured
Selecting a Data-Recording Procedure
Evaluation
Reliability and Validity
Summary

6 Replication 110
DAVID L. GAST
Why Replicate?
Types of Replication
Direct Replication
Clinical Replication
Systematic Replication
External Validity and Single Subject Research
Generality of Findings: Group vs. Single Subject Research Methodology
Generalization Continuum
"N of 1" Single Subject Studies and Their Contribution
General Recommendations for Starting a Systematic Replication
Summary

7 Dependent Measures and Measurement Procedures 129
KEVIN AYRES and DAVID L. GAST
Parameters of Measurement
Selecting a Dependent Measure
Number
Percent
Rate
Duration
Latency
Trials, Sessions, Time, and Errors to Criterion
Magnitude
Selecting a Measurement Procedure
Automated and Computer-Based Recording
Direct Measurement of Permanent Products
Direct Observational Recording

Data-Collection Forms
Situational Information
Performance Information
Summary Information
Reliable Measurement
Selection and Training of Human Observers
Calculation of IOA
Summary

8 Visual Representation of Data 166
AMY D. SPRIGGS and DAVID L. GAST
The Purpose of Graphic Displays
Types of Graphic Displays
Simple Line Graphs
Simple Bar Graphs
Cumulative Graphs
Semilogarithmic Charts
Guidelines for Selecting and Constructing Graphic Displays
Figure Selection
Graph Construction
Data Presentation
Using Computer Software to Construct Graphs
Tables
Table Construction
Summary

9 Visual Analysis of Graphic Data 199
DAVID L. GAST and AMY D. SPRIGGS
Design Notation
Visual Analysis of Graphic Data: General Guidelines
Within-Condition Analysis
Between Adjacent Condition Analysis
Analysis of Changes Across Similar Conditions
Sample Visual Analysis
Analysis Within Condition
Analysis Between Adjacent Conditions
Analysis Between Similar Conditions
Summary

10 Withdrawal and Reversal Designs 234
DAVID L. GAST and DIANA HAMMOND
Baseline Logic
A and B Designs
Internal and External Validity
Considerations
Advantages

Limitations
Concluding Comments
A-B Design
Internal and External Validity
Considerations
Advantages
Limitations
Applied Example: A-B Design
Concluding Comments
A-B-A Design
Internal and External Validity
Considerations
Advantages
Limitations
Applied Example: A-B-A Design
Concluding Comments
A-B-A-B Design
Internal and External Validity
Considerations
Advantages
Limitations
Applied Example: A-B-A-B
Applied Example: A-B-A-B with Concurrent Monitoring
Applied Example: A-BC-B-A-B Design
Concluding Comments
Variations of the A-B-A-B Design
B-A-B Design
A-B-A′-B Reversal Design
Withdrawal vs. Reversal Design Distinction
Multitreatment Designs
Summary

11 Multiple Baseline and Multiple Probe Designs 276
DAVID L. GAST and JENNIFER LEDFORD
Baseline Logic and Multiple Baseline and Multiple Probe Designs
Internal Validity
Considerations
General Guidelines
Advantages
Limitations
Multiple Baseline and Multiple Probe Designs Across Behaviors
Internal Validity
General Guidelines
Advantages
Challenges and Limitations
Applied Example: Multiple Baseline Design Across Behaviors

Multiple Baseline Design Across Behaviors: Practical Considerations
Multiple Probe Design (Days)
Probe Terminology
Multiple Probe Design Variations
General Guidelines for the Multiple Probe Design (Days)
Applied Example: Multiple Probe Design (Days) Across Behaviors
Multiple Probe Design (Conditions)
General Guidelines for the Multiple Probe Design (Conditions)
Applied Example: Multiple Probe Design (Conditions) Across Behaviors
Multiple Probe Designs: Benefits and Limitations
Concluding Comments
Multiple Baseline and Multiple Probe Designs Across Conditions
Internal Validity
Considerations
Applied Example: Multiple Baseline Design Across Conditions
Concluding Comments
Multiple Baseline and Multiple Probe Designs Across Participants
Internal Validity
Considerations
Applied Example: Multiple Baseline Design Across Participants
Applied Example: Multiple Probe Design Across Participants
Concluding Comments
Monitoring the Performance of a Group
Summary

12 Comparative Intervention Designs 329
MARK WOLERY, DAVID L. GAST, and DIANA HAMMOND
Types of Comparative Studies
Comparison of Competing Interventions
Comparison of an Innovation to an Established Intervention
Comparisons to Refine Interventions
Comparison to Understand Interactions
Special Issues with Comparative Studies
Multitreatment Interference
Nonreversibility of Effects
Separation of Treatments Issue
Comparative Single Subject Designs
Multitreatment Designs
Applied Example: A-B-BC-A-BC-B-BC Design
Alternating Treatments Design (ATD) and Multi-element Design (M-ED)
Adapted Alternating Treatments Design (AATD)
Applied Example: AATD
Parallel-Treatments Design (PTD)
Applied Example: PTD (Probe Days)
Summary

13 Variations of Multiple Baseline Designs and Combination Designs 382
DAVID L. GAST and JENNIFER LEDFORD
Changing Criterion Design
Internal Validity
Guidelines and Considerations
Advantages
Limitations
Applied Example: Changing Criterion Design—Increase Behavior
Applied Example: Changing Criterion Design—Decrease Behavior
Concluding Comments
Nonconcurrent (or Delayed) Multiple Baseline Design
Combination Designs
Guidelines and Considerations for Combining Designs
Applied Example: Multiple Baseline Design Across Behaviors and Participants
Applied Example: Multiple Probe Design Across Participants and Adapted Alternating Treatments Design (AATD)
Applied Example: Multiple Baseline Design Across Settings and Nonconcurrent Multiple Baseline Design Across Participants
Applied Example: Alternating Treatments Design and A-B-A-B Withdrawal Design
Resolving "Ambiguities" of Multiple Baseline and Multiple Probe Designs
Internal Validity Issues
History
Testing and Procedural Contrast
Premature Introduction of the Independent Variable
Summary

14 Statistics and Single Subject Research Methodology 417
JONATHAN M. CAMPBELL and CAITLIN V. HERZINGER
Visual Analysis and Statistical Analysis
The Argument for Visual Analysis
Limitations of Visual Analysis
Why Consider Statistical Analysis of Single Subject Data?
Proposed Statistical Procedures for Use with Single Subject Research Data
Procedures for Statistical Analysis
General Statements about Statistical Analysis of Data
Meta-Analysis and Evidence-Based Practice
Meta-Analysis: What Is It and What Is Its Purpose?
Guidelines for Conducting a Meta-Analysis
Adoption of QUOROM Guidelines for Single-Case Meta-Analysis
Summary

List of Contributors 454
Author Index 456
Subject Index 462

Preface

Throughout my career as a professor of special education, first at the University of Kentucky (1975–1989) and later at the University of Georgia (1990–present), my interest has been to encourage students to be active participants in research, both as a "scientist-practitioner" and as a collaborator with applied researchers. I suppose this was instilled in me when I was a doctoral student at the University of Kansas (1971–1975) in what was then the Department of Human Development and Family Life (HDFL). During that time I was fortunate to be inspired by some of the best behavioral researchers in the field of applied behavior analysis, including Drs. Joseph Spradlin, my mentor, Sebastian Striefel, James Sherman, Donald Baer, Montrose Wolf, and others. The faculty at the K.U. encouraged and supported the active involvement in research by its master's and doctoral students, as well as teachers and therapists working at one of the many research sites supported by federal grants. It was through the mentorship model adopted by HDFL faculty that I learned that some of the best applied research questions are generated by practitioners, and if practitioners are taught research skills, specifically single subject research methodology, they can be active applied researchers and contributors to the applied research literature. It is to this end that this book has been written.

My goal in writing this book was to present a thorough, technically sound, user friendly, and comprehensive discussion of single subject research methodology. The contributing authors and I assume that those who read the book will have had an introduction to applied behavior analysis and that readers will be familiar with basic behavioral terminology, principles, and procedures. The primary audiences, for whom the book was written, are graduate students, scientist-practitioners, and faculty from a variety of disciplines including special and general education; school, child, and clinical psychology; speech, occupational, recreation, and physical therapy; and social work (i.e., anyone from the social and behavioral sciences, and education, who has an interest in researching the effectiveness and efficiency of instructional and treatment programs). In light of the intended audiences, the applied research examples abstracted, tabled, and cited throughout the book sample a wide range of studies published in a variety of refereed professional journals that represent a number of disciplines, thereby showing the versatility of single subject research methodology. These studies were chosen because of their being applied, behavioral, conceptually systematic, technological, analytical, and effective. Most, but not all, studies referred to in chapters describe behavioral investigations that have been conducted with children and adults with special needs, specifically individuals with intellectual disabilities, autism spectrum disorders, and behavioral disorders. Although some faculty teaching a course in single subject research design may choose to supplement the book with recently published full-text examples from the research literature, an attempt was made to

include a sufficient number and range of examples so that supplemental readings would not be necessary. That decision is left to the instructor.

The organization of the book, including the sequence in which chapters are presented, is based on my 30-plus years teaching a course on single subject research methodology to graduate students in special education and psychology. Instructors, however, may choose to assign chapters in a different order since earlier chapters are rarely necessary to understanding content presented in later chapters. The exception to this is Chapters 5 ("General Factors in Measurement and Evaluation"), 6 ("Replication"), 7 ("Dependent Measures and Measurement Procedures"), and 9 ("Visual Analysis of Graphic Data"), that are important to the critique of experimental designs and the applied research study examples abstracted in the design chapters. The book begins with a general discussion of Applied Research in Education and Behavioral Sciences (Chapter 1) in which the various research approaches used in the behavioral sciences and education are introduced. Characteristics, strengths and limitations, and established guidelines are presented for each approach. In Chapter 2 ("Scientific Research in Educational and Clinical Settings") a case is made for educators and clinicians to be actively involved in applied research as principal investigators or as collaborators with applied researchers as means for improving their practice. An attempt is made to show how behavioral science research and education are not as dissimilar as one might think if practitioners agree to evaluate their practice within the context of a single subject research design. Through such participation educators and clinicians can add to our understanding on how to better serve our students and clients. Chapter 3 ("Ethical Principles and Practices") addresses the expected professional behaviors of investigators who conduct research in applied settings. It also outlines a common protocol for receiving permission from university Institutional Review Boards (IRB), prior to conducting research with human subjects, and what safeguards must be in place to protect study participants. Several technical writings tasks are important to the design, approval, and dissemination of research. Chapter 4 ("Writing Tasks: Literature Reviews, Research Proposals, and Final Reports") describes how to complete these writings assignments.

A hallmark of single subject research is objective measurement, formative evaluation, and control of common threats to internal validity that could compromise experimental findings. These topics are discussed in Chapter 5 ("General Factors in Measurement and Evaluation"), while Chapter 6 ("Replication") discusses the importance of repeating experimental effects within and across participants in order to have confidence in research findings. The importance of systematic replication in behavioral science research is also addressed in Chapter 6. Throughout the book emphasis is placed on the direct, repeated, and reliable measurement of behavior. These topics and procedures related to each are operationalized in Chapter 7 ("Dependent Measures and Measurement Procedures"). Chapter 8 ("Visual Representation of Data") and Chapter 9 ("Visual Analysis of Graphic Data") both emphasize the importance of graphic displays as a means for communicating and analyzing single subject research findings. Chapter 8 describes guidelines for the construction of graphic displays, as well as tables, while Chapter 9 describes experimental variables that should be attended to when conducting a visual analysis of data plotted on a line graph. How to conduct both within condition and between adjacent conditions visual analyses are presented and exemplified.

In the remaining chapters of the book the various single subject research designs are critically discussed. Each chapter has a common format in that: (a) each design is described; (b) how threats to internal and external validity are evaluated and controlled are discussed; (c) considerations and guidelines for using a design are presented; (d) advantages and limitations are overviewed; (e) applied research examples are abstracted; (f) sample studies are outlined in table format; and (g) key points are summarized. In Chapter 10 ("Withdrawal and Reversal

Designs") baseline logic, quantitative descriptive designs ("A" and "B" designs), simple A-B correlational design, and various repeated time-series designs (A-B-A, A-B-A-B, B-A-B, and A-B-A'-B) capable of demonstrating a functional relation are presented and exemplified. Multiple baseline and multiple probe designs, and their three variations (across behaviors, conditions, and participants) are discussed in Chapter 11 ("Multiple Baseline and Multiple Probe Designs"). Specific attention is given to differentiating multiple baseline and multiple probe designs, as well as describing the two types of multiple probe designs (probe days and probe conditions). In Chapter 12 ("Comparative Intervention Designs") the types of comparative research questions asked by behavioral researchers are presented, as are the single subject research comparative designs used to answer those questions (multitreatment designs, Alternating Treatments Design, Adapted Alternating Treatments Design, Parallel Treatments Design). The more common single subject research designs are sometimes not practical for some research questions, or they may not adequately evaluate and control some threats to internal validity. In these cases some behavioral researchers have used variations of the multiple baseline design (e.g., changing criterion design, "delayed" or nonconcurrent multiple baseline design) that have practical advantages but which have research limitations. Other researchers have combined single subject research designs to strengthen evaluation of experimental control (e.g., multiple baseline across participants combined with multiple probe across behaviors; alternating treatment design combined with multiple baseline across participants) by increasing the number of replication attempts. These designs and topics are discussed and exemplified in Chapter 13 ("Variations of Multiple Baseline Designs and Combination Designs"). Chapter 14 ("Statistics and Single Subject Research Methodology"), the final chapter of the book, addresses the role and place of statistical analysis with single subject research design data. Proposed procedures are presented, as are precautions in their use. A case is made for conducting meta-analyses of single subject research investigations, although still controversial, as a quantitative means for identifying and supporting evidenced-based practice.

Whether you chose to assume the role of scientist-practitioner, collaborator on research projects initiated by others, or merely a consumer of single subject research, the information covered in this book will help you understand the logic behind single subject research design, the importance of repeated, direct, and reliable measurement, the requirements for evaluating and controlling alternative explanations for research findings, the visual analysis of graphic data, and the importance of replication. The guidelines presented throughout the text are just that, guidelines, intended to assist you in the design, analysis, implementation, and dissemination of single subject research. As an applied researcher, use the guidelines to assist you in gaining an understanding of your research site and its practical constraints before beginning your study, and plan accordingly. Through your understanding of single subject research methodology and your research efforts, and those of other behavioral researchers, we will accumulate evidence that supports promising and best practices.

DLG

Acknowledgments

This project would not have been undertaken had it not been for the generosity of my friend and former colleague at the University of Kentucky, Dr. James W. Tawney, who signed over the copyright of a book we co-authored, *Single Subject Research in Special Education*, published in 1984. The purpose of that book, much like the purpose of this book, was to encourage special education students, teachers, therapists, and other professionals working with individuals with special needs, and who adopted a behavior analytic approach, to become active applied researchers. Through Jim's mentorship early in my career and his invitation to co-author the above single subject research design book, I developed better analytical skills that made me a better researcher and university instructor. I want to thank Dr. Mark Wolery, a dear friend and respected colleague for over 30 years, who has been involved with this project from the very beginning. His encouragement to sign the contract, willingness to participate by sharing his time and expertise in writing two chapters, and availability to critique and provide feedback throughout the writing and editing of the book has been greatly appreciated. Because of my being "technology challenged" I can't imagine what the manuscript would have looked like had it not been for Ms. Amy Spriggs and Ms. Diana Hammond, two dedicated and accomplished doctoral students who I have had the privilege of advising and working with for the past few years. I sincerely appreciate the willingness of each author and co-author who provided contributions throughout the book. I also want to thank the graduate students with whom I have worked at the University of Kentucky (1975–1989) and University of Georgia (1990–present). Had it not been for their insightful research questions, persistence, and patience, I am confident my research career would have been less interesting and productive. Thank you for challenging my analytical abilities. And finally, I want to thank my wife, Kathy Boyle-Gast, and daughter, Hunter Gast, for their encouragement and tolerance through the project. Their support has always been appreciated on this and other projects.

1

Applied Research in Education and Behavioral Sciences

David L. Gast

Evidence-Based Practice and the Scientific Method
General Guidelines for Evaluating Supportive Evidence
Dissemination of Evidence-Based Practices in Education
Research Approaches in the Behavioral Sciences
Experimental, Quasi-Experimental, and Correlational Designs
Group Research Approach
Qualitative Research Approaches
Single Subject Research Approach
Research Approaches and Generalization to the Individual
Group Research Approach
Qualitative Research Approaches
Single Subject Design Approach
Summary

At no time in education and behavioral sciences has accountability been more important. Since the passage of the Individuals with Disabilities Education Act (IDEA) and No Child Left Behind Act (NCLB), "evidence-based practice" has been the guiding principle for determining whether a treatment or instructional program should be implemented or maintained. Though the phrase "evidence-based practice" is relatively new, the idea that research should guide practice is not, particularly for those of us trained in applied behavior analysis. Baer, Wolf, and Risley (1968), in their seminal article that defined applied behavior analysis, emphasized the importance of quantitative research-based decisions for guiding practice whether you were a psychologist, educator, speech/language pathologist, occupational therapist, recreation therapist, etc. Their emphasis on a low-inference decision model, based on repeated measurement of behavior within the context of a single subject experimental design, set a standard for practitioners determining intervention effectiveness more than 40 years ago. At the time of their article, published in the inaugural issue of the *Journal of Applied Behavior Analysis*, there was

no shortage of critics who questioned the viability and desirability of an empirical scientific approach for studying and understanding human behavior, a response in part due to the controversial position articulated by B. F. Skinner in his classic book, *Science and Human Behavior* (1953). Having passed the test of time, as evidenced by the numerous single subject research design studies that have influenced practice across many disciplines, it has been shown that a behavioral approach can and does provide a scientific framework for understanding and modifying behavior in positive ways. Few would question that Baer et al. established evidence-based practice as a core value for applied behavior analysts, a value that has yielded best and promising practices across numerous disciplines within the behavioral sciences.

Evidence-Based Practice and the Scientific Method

What constitutes a "practice"? Horner et al. (2005) defined *practice* as "a curriculum, behavioral intervention, systems change, or educational approach designed to be used by families, educators, or students with the express expectation that implementation will result in measurable educational, social, behavioral, or physical benefit" (p. 175). This definition applies to specific interventions and broader approaches used by professionals who provide educational and clinical services. It should not go unnoticed that the definition includes mention of a "measurable" benefit to those who are the focus of the practice.

What constitutes *evidence* that supports implementation of a particular practice? Must evidence be quantitative? Is clinical or professional judgment a consideration? Do data need to be collected within the context of a randomized experimental group design or randomized clinical trial? To what extent can research outcomes based on quasi-experimental group, single subject, or qualitative research designs be used to support implementation of a curriculum, behavioral intervention, systems change, or educational approach? Answers to these questions are important since different research methods and designs yield different types of data and different professionals and researchers have different opinions as to which type of research methodology yields the most reliable and valid results that will generalize across individuals, conditions, and time. *The research question should determine the research method and design (group, single subject, or qualitative) chosen.* In behavioral sciences, "trustworthiness" or credibility of research findings is based on the rigor of the scientific method employed and the extent to which the research design controls for alternative explanations. *The scientific method requires investigator objectivity, reliability of measurement, and independent replication of findings.* As a scientist you will be expected to see things as they are not as you wish them to be; this will necessitate defining the target behavior (or event) clearly and concisely so that two independent observers consistently agree on scoring what they observe. Finally, you will need to be patient to see if your research findings stand up to the scrutiny of other researchers when they attempt to replicate your results. This latter criterion is critical, as *replication is at the heart of the scientific method*, without which you cannot have confidence in study findings.

Behavioral scientists have numerous scientific research designs from which to choose in their quest for answers to research hypotheses and questions. There is general agreement among researchers that different research questions or objectives require different research approaches, i.e., no one research method or design is appropriate for answering all research questions. However, for behavioral scientists, certain research methods and designs are deemed superior to others when generalizing findings to individuals or groups. This judgment is based on the degree to which data-collection procedures, data analyses, and data reporting are viewed as objective, reliable, and valid, and the extent to which it is believed that the study could be replicated and yield similar findings. Studies that are based on investigator perceptions and descriptions, that

fail to objectively define and evaluate the reliability of investigator observations, and that lack detailed descriptions of conditions under which data are collected, thus making replication difficult if not impossible, are judged as lacking scientific rigor and "trustworthiness" of findings. Judging the rigor of the scientific method of a study that supports a particular practice is at the heart of determining whether a practice is, in fact, evidence-based.

To that end, in determining the rigor of the science supporting a particular policy, procedure, or practice, most professional organizations have recommendations and guidelines on their websites for evaluating research study adequacy (e.g., American Psychological Association, www.apa.org; American Speech-Language-Hearing Association, www.asha.org; Association of Behavior Analysis International, www.abainternational.org; Council for Exceptional Children, www.cec.org). Odom et al. (2005) point out that interest in and guidelines for the evaluation of research supporting clinical and educational practices has been addressed by medical, social science and educational professional organizations for many years. As a result of No Child Left Behind (NCLB) legislation, families are increasingly holding professionals accountable for their choice of practices used with their children. Parents and others expect to see positive changes in behavior, an expectation that is both reasonable and consistent with ethical standards of educational and clinical service professional organizations. Take, for example, an excerpt from a Policy Statement on "The Right to an Effective Behavioral Treatment," passed by the Association of Behavior Analysis International (ABAI) membership in 1989, that reads:

> An individual is entitled to effective and scientifically validated treatment; in turn, the behavior analyst has an obligation to *use only those procedures demonstrated by research to be effective*. Decisions on the use of potentially restrictive treatment are based on consideration of its absolute and relative level of restrictiveness, the amount of time required to produce a clinically significant outcome, and the consequences that would result from delayed intervention.
>
> (ABAI, 1989; italics added)

Applied behavior analysts have historically held themselves accountable for designing and employing curricula, interventions, systems for change, and educational/therapeutic approaches that bring about positive behavior change. As will be discussed throughout this book, single subject research methodology will permit you as a "*scientist-practitioner*," a label coined by Barlow, Hayes, and Nelson (1984) to describe interventionists who make data-based decisions an integral part of their practice, to repeatedly evaluate your practices, allowing you to maintain them when data support their effectiveness; modify them when progress is slow or plateaus; or abandon them when necessary and implement another promising practice with an emerging evidence base. These research decisions can be made while retaining the experimental integrity of a study if you are familiar with measurement and design guidelines presented in later chapters. For now, I recommend that you visit your professional organization's website and review the most recent recommendations for supporting evidence-based practice.

General Guidelines for Evaluating Supportive Evidence

The National Research Council (NRC), at the request of the U.S. Department of Education's Office of Special Education Programs (OSEP), was assigned the task of developing a set of guidelines for evaluating the scientific rigor and trustworthiness of research related to autism spectrum disorders (ASD). A committee of respected researchers in the areas of early childhood education and ASD was asked "to integrate the scientific, theoretical, and policy literature and create a framework for evaluating the scientific evidence concerning the effects and features

of educational interventions for young children with autism" (Committee on the Educational Interventions for Children with Autism, 2001, p. 13). The Committee recognized that there are numerous sources for generating evidence, with some approaches yielding greater scientific evidence than others. They also recognized that different research questions require different research methodologies, and in spite of current popularity of some approaches (e.g., clinical descriptions), greater scientific credence was assigned to findings based on quantitative research approaches. Guidelines adopted by the committee and recommended for use when evaluating scientific rigor of research supporting a curriculum, procedure, or policy are presented in Table 1.1. Three primary areas are addressed: Internal Validity, External Validity/Selection Bias, and Generalization. *Internal validity* refers to the degree to which the research design controls for extraneous or confounding variables, variables that could support an alternative explanation for the findings. *External validity/selection bias* refers to the number of study participants and how participants are selected, with greater external validity assigned to studies with a larger number of participants who are randomly assigned to experimental conditions. *Generalization* refers to the extent to which an experimental effect is observed beyond the treatment setting, under natural conditions, and maintained over time. Under each of these three areas there are four categories or descriptions that may or may not represent a study, or series of studies you are evaluating. These categories are presented in a hierarchy from most (first listed) to least (last listed) degree of trustworthiness of research findings. To determine the level of confidence you should have in the evidence supporting a practice, identify the statement under each area that best represents the research reviewed. As a general guideline, if you were to assign a score to each statement (e.g., 1–4), the lower the score the greater the likelihood that the findings are reliable, valid, and will generalize to similar individuals. Unfortunately, deciding the merits of research supporting a practice is not that simple or "cut and dried." Clinical and educational research can be compromised by limited access to a population, ethical concerns regarding random assignment or withholding of a treatment, or the expense of independent replication. As discussed in Chapter 3, professional judgment must be used when evaluating and conducting applied research. When there are few participants in a study, as is typically the case in single subject research design studies, successful independent replications increase confidence. In fact, it has been suggested that such "systematic replications" (Sidman, 1960) have greater trustworthiness when generalizing findings to other individuals who exhibit similar behaviors emitted at a similar frequency or magnitude (Wolery & Ezell, 1993). You should be aware that although the commonly held "gold standard" for research trustworthiness is assigned to research findings generated by randomized experimental group designs, seldom are these studies independently replicated. This is in part due to cost. The point I am making here is that the NRC guidelines for evaluating research are a good starting point, but informed judgment must also be used in determining the credibility of evidence supporting a practice. It is important to understand threats to internal validity (discussed in Chapter 5) and how a research design evaluates and controls for these threats. You must also be familiar with how external validity is established with each research approach and whether findings from a study or series of studies are likely to generalize to individuals with whom you are working and/or studying. As Skinner (1953) noted,

> In general a science is helpful in dealing with the individual only insofar as its laws refer to individuals. A science of behavior which concerns only the behavior of groups is not likely to be of help in our understanding of the particular case.
>
> (p. 19)

Although the NRC guidelines give the highest degree of trustworthiness to randomized

experimental group designs and randomized clinical trials, you must ask whether these studies or trials adequately controlled for threats to internal validity and whether the findings have been independently replicated. Only through independent replication can investigator bias and research skill in controlling threats to validity be truly assessed.

Dissemination of Evidence-Based Practices in Education

It is important that practices supported by research be disseminated to practitioners. To that end, the Education Science Reform Act of 2002 was established within the U.S. Department of Education's Institute of Education Sciences (IES; www.ed.gov/about/offices/list/ies); its mission, to "provide rigorous evidence on which to ground education practice and policy" by government-funded research projects. IES's oversight responsibilities was a direct response to concerns regarding the quality of educational research and the requirement put forth in NCLB that teachers use scientifically proven practices (Odom et al., 2005). To disseminate its findings, IES established the What Works Clearinghouse:

> to provide educators, policymakers, researchers, and the public with a central and trusted source of scientific evidence of what works in education. The WWC aims to promote informed education decision making through a set of easily accessible databases and user friendly reports that provide education consumers with high quality reviews of the

Table 1.1 National Research Council's Committee on the Educational Interventions for Children with Austism (2001) Guidelines Used to Evaluate Studies

BOX 1–1 Guidelines Used to Evaluate Studies

Every research report considered by the committee was assigned to one category (I–IV) for each area (A, B, and C).

A. Internal Validity: Control for nonspecific factors, such as maturation, expectancy, experimenter artifacts

I. Prospective study comparing the intervention to an alternative intervention or placebo in which evaluators of outcome are blind to treatment status

II. Multiple baseline, ABAB design, or reversal/withdrawal with measurement of outcome blind to treatment conditions or pre-post design with independent evaluation

III. Pre-post or historical designs or multiple baseline, ABAB, reversal/withdrawal not blind to treatment conditions

IV. Other

B. External Validity/Selection Biases

I. Random assignment of well-defined cohorts and adequate sample size for comparisons

II. Nonrandom assignment, but well-defined cohorts with inclusion/exclusion criteria and documentation of attrition/failures; additionally adequate sample size for group designs or replication across three or more subjects in a single-subject design

III. Well-defined population of three or more subjects in single-subject designs or sample of adequate size in group designs

IV. Other

C. Generalization

I. Documented changes in at least one natural setting outside of treatment setting (includes social validity measures)

II. Generalization to one other setting or maintenance beyond experimental intervention in natural setting in which intervention took place

III. Intervention occurred in natural setting or use of outcome measures with documented relationship to functional outcome

IV. Not addressed or other

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> effectiveness of replicable educational interventions (programs, products, practices, and policies) that intend to improve student outcomes.
>
> (WWC; http://ies.ed.gov/ncee/wwc)

Prior to 2006 the WWC only "certified" and disseminated practices that were shown to be effective by a randomized experimental group design or random clinical trial. However, in September 2006, in one of its technical working papers, "Study Design Classification" (WWC 2006a), it revised its guidelines to include three additional research designs: "quasi-experiment with equating on pretest, regression discontinuity design, or single-case design with multiple changes of condition." This policy revision showed an understanding by IES and WWC that applied research studies, particularly studies conducted with low-incidence populations and conducted in clinical and classroom settings, require research designs other than those that randomly assign participants to experimental conditions. Standards for evaluating experimental and quasi-experimental group design studies have been put forward (WWC 2006b); however, specific standards for evaluating single subject research design studies have not, as of July 9, 2008. To be kept abreast of current standards, particularly the development of those for single subject research design studies, periodically check the WWC website and its technical reports for updates on evidence standards for reviewing studies.

Research Approaches in the Behavioral Sciences

As the book title connotes, the focus of this text is on single subject research methodology, also referred to as single case research design, and its use by applied researchers in behavioral sciences. In spite of this single research-approach focus, it is important for you to be able to compare and contrast research approaches on the basis of their research logic, strategies for controlling threats to internal validity, and generalization of findings to individual cases. Through your analysis and understanding of research approaches you will be better able to choose the appropriate research design for answering your research question(s). As previously noted, no one research approach or design is appropriate for answering all research questions. Thus it is your responsibility, both as a consumer of and contributor to research, to be familiar with the various research approaches used in behavioral sciences. In the sections that follow common research approaches and designs are briefly overviewed. More detailed design descriptions and analyses are found elsewhere in such general research methodology texts as deMarrais and Lapan (2004), Fraenkel and Wallen (2006), Portney and Watkins (2000), and Schlosser (2003).

Experimental, Quasi-Experimental, and Correlational Designs

Experimental design studies are defined by an investigator's manipulation of an independent variable (e.g., intervention, treatment, or practice; i.e., system of least prompts, self-monitoring, repeated practice) to verify what effect it has on a dependent variable (e.g., frequency, duration of target behavior; i.e., number of steps completed correctly, percentage of time on-task, number of words read correctly per minute). The act of intentionally manipulating some variable (e.g., stimulus presentation pace, response consequence contingency, materials) to see if there is a measurable change in a behavior (or event) differentiates experimental research from other research approaches. Experimental design studies (a) describe the target behavior(s), (b) predict what impact the independent variable will have on the dependent variable(s), and (c) test to see if the prediction is correct. In so doing, the research design must control for alternative explanations for the observed behavior change(s). What differentiates an experimental design study from a *quasi-experimental design* study, at least within the context of the

group research design approach, is how research participants are assigned to study conditions. In experimental group design studies participants are randomly assigned to a study condition (e.g., experimental group or control group; intervention A or intervention B), while quasi-experimental group design studies do not use random assignment of participants but other strategies to control for differences in study-group composition, e.g., counterbalancing techniques, participant matching (Fraenkel & Wallen, 2006). Regardless of whether a study uses an experimental or quasi-experimental design, if the prediction "proves" true, it is said there is a *functional relation* (i.e., cause–effect relation) between independent and dependent variables. The demonstration of a functional relation adds evidence in support of the independent variable being a promising and possibly "best practice" if findings are independently replicated. Greater support is attributed to results of an experimental group design study, compared to a quasi-experimental group design study, because of the random assignment of participants.

Correlational design studies, like experimental and quasi-experimental design studies, describe and predict the relation between independent and dependent variables, however, *in correlational studies there is no attempt by the investigator to verify the prediction.* Such studies represent a quantitative-descriptive research approach in which the relation between variables is established by using a correlation coefficient (Fraenkel & Wallen, 2006). When independent and dependent variables co-vary there is said to be a correlational relation between variables. Practices supported by correlational evidence are deemed less trustworthy or convincing than those supported by experimental and quasi-experimental evidence since correlational design studies do not rule out alternative explanations because there is no attempt to replicate the experimental effect of the independent variable on the dependent variable.

Group Research Approach

Gersten, Fuchs, Compton, Coyne, Greenwood, and Innocenti (2005) provide an excellent discussion of indicators for evaluating scientific rigor of group experimental and quasi-experimental research reports and proposals. Much of what is presented in this section is a summary of key points they present in determining the level of support assigned to group studies investigating the efficacy of a practice. They point out that there was not complete agreement among authors on all issues discussed. Nevertheless their presentation provides a framework from which to judge the level of support for an evidence-based practice with group designs. Table 1.2 summarizes the "Essential and Desirable Quality Indicators for Group Experimental and Quasi-Experimental Research Articles and Reports."

Characteristics of Group Design

The basic logic underlying all group research studies is that a large number of individuals are divided and assigned to one of two or more study conditions. Study conditions could be a control condition, in which participants *are not* exposed to the independent variable, and treatment condition, in which participants *are* exposed to the independent variable. When comparing two different treatments, participants would be equally divided between the two treatments. In some group studies more than two conditions may be compared, in which case an equal number of participants would be assigned to each of the conditions (e.g., 30 assigned to control, 30 assigned to treatment A, 30 assigned to treatment B). A critical variable to consider when evaluating a group study is how participants are assigned to study conditions. The optimal method is random assignment of participants (experimental study), but this is not always possible and may depend on the research objective or population being studied. When random assignment of participants is not feasible, it is recommended that

Table 1.2 Essential and Desirable Quality Indicators for Group Experimental and Quasi-Experimental Research Articles and Reports

Essential Quality Indicators

Quality Indicators for Describing Participants

1. Was sufficient information provided to determine/confirm whether the participants demonstrated the disability(ies) or difficulties presented?
2. Were appropriate procedures used to increase the likelihood that relevant characteristics of participants in the sample were comparable across conditions?
3. Was sufficient information given characterizing the interventionists or teachers provided? Did it indicate whether they were comparable across conditions?

Quality Indicators for Implementation of the Intervention and Description of Comparison Conditions

1. Was the intervention clearly described and specified?
2. Was the fidelity of implementation described and assessed?
3. Was the nature of services provided in comparison conditions described?

Quality Indicators for Outcome Measures

1. Were multiple measures used to provide an appropriate balance between measures closely aligned with the intervention and measures of generalized performance?
2. Were outcomes for capturing the interventions effect measured at the appropriate times?

Quality Indicators for Data Analysis

1. Were the data analysis techniques appropriately linked to key research questions and hypotheses? Were they appropriately linked to the limit of analysis in the study?
2. Did the research report include not only inferential statistics but also effect size calculations?

Desirable Quality Indicators

1. Was data available on attrition rates among intervention samples? Was severe overall attrition documented? If so, is attrition comparable across samples? Is overall attrition less than 30%?
2. Did the study provide not only internal consistency reliability but also test-retest reliability and interrater reliability (when appropriate) for outcome measures? Were data collectors and/or scorers blind to study conditions and equally (un)familiar to examinees across study conditions?
3. Were outcomes for capturing the intervention's effect measured beyond an immediate posttest?
4. Was evidence of the criterion-related validity and construct validity of the measures provided?
5. Did the research team assess not only surface features of fidelity implementation (e.g., number of minutes allocated to the intervention or teacher/interventionist following procedures specified), but also examine quality of implementation?
6. Was any documentation of the nature of instruction or series provided in comparison conditions?
7. Did the research report include actual audio or videotape excerpts that capture the nature of the intervention?
8. Were results presented in a clear, coherent fashion?

Note:

* A study would be acceptable if it included only measures of generalized performance. It would not be acceptable if it only included measures that are tightly aligned.

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interventionists be randomly assigned to conditions. Gersten et al. (2005) point out that random assignment of participants does not guarantee study group equivalence, an important consideration when analyzing group research findings. *It is the fundamental logic of group design, experimental and quasi-experimental, that groups of participants assigned to each study condition are equivalent on "key" characteristics or status variables (e.g., chronological age, gender, ethnicity, test scores) at the start of a group study* (Rosenberg et al., 1992). By starting with equivalent groups across conditions, it is possible to attribute later differences between groups to the independent variable rather than group composition. Because group equivalence is critical, some investigators have chosen to match participants on key characteristics prior to the start of their study and then randomly assign one matched member to each study condition. Implied in this process is the importance of the researcher providing a detailed description of

group members, thereby convincing study evaluators that groups were equivalent at the start of the study.

Other participant and interventionist variables should also be addressed when evaluating or reporting results from group studies, including participant attrition and interventionist characteristics. Specifically, it is important to note the number of participants who have withdrawn from a study and the condition to which they were assigned. If attrition is comparable across conditions there is not a problem, however, if one condition has a substantially higher attrition rate than another condition, problems arise when analyzing the data, since groups will no longer be comparable in number. In such cases it is always important to document and report the reasons for participant withdrawal, noting whether it was in some way due to the condition to which they were assigned. For studies in which one or more interventionists are participating, it is important to describe each interventionist in detail so that there are no critical differences between them (e.g., education, certification, experience), as some differences could influence the consistency and fidelity with which the independent variable is implemented. To avoid this potential problem, researchers randomly assign or counterbalance interventionists across conditions. When neither option is possible for logistical reasons (e.g., clinical group or teacher classroom assignment), *procedural fidelity* data become increasingly important in the analysis of findings, i.e., the degree to which condition procedures were followed as specified in the research proposal.

Controlling Threats to Internal Validity

All quantitative research studies, group and single subject design studies, attempt to evaluate and control for alternative explanations for their results (see Chapter 5 for information on threats to internal validity). To accomplish this, researchers select a research design and measurement system that give reviewers confidence that study findings were, in fact, due to differences in study conditions. This effort begins with a clear and concise description of each study condition. General condition labels or descriptions (e.g., Self-Management, Direct Instruction, Desensitization Strategy) are insufficient, and more detailed "point-by-point" or technological descriptions are required. All condition descriptions (control and treatment) should be described in sufficient detail to allow an independent investigator to replicate procedures or to conduct a meta-analysis or synthesis of research on a topic (see Chapter 14 for information on meta-analyses).

The measurement system should also be described in detail, allowing reviewers to judge the validity and reliability of measures. Multiple measures "closely aligned to the intervention and measures of generalized performance" (p. 158) are encouraged, as is "test-retest reliability," and use of tests that have established validity. Internal consistency reliability (i.e., coefficient alpha) should be calculated and reported (Gersten et al., p. 158–159). While pre/posttest measures are deemed adequate, inclusion of multiple measures over the duration of a study is preferred since more complex statistical analysis procedures are available (e.g., Hierarchical Linear Modeling). Another variable that should be addressed is the degree to which data collectors and interventionists are familiar to participants and "blind" to study hypotheses. Experimenter bias can be avoided if data collectors are equally familiar (or unfamiliar) to participants, however, experimenter or interventionist bias requires frequent reliability checks on independent and dependent variables to ensure procedural fidelity and scoring consistency.

The group research approach is the most common research methodology used in the behavioral sciences. Group research designs are well-suited for large-scale efficacy studies or clinical trials in which a researcher's interest is in describing whether a practice or policy with a specific population, on average, will be effective. With such research questions a group design

methodology is recommended. Numerous group designs and statistical analysis procedures are available for your consideration if you choose to study group behavior. As will be discussed in a later section of this chapter, a question you must ask is, "To what extent do results generated by a group design study generalize to a specific individual?" To paraphrase Barlow et al. (1984), generalization of group research findings to individuals requires a "leap of faith," the extent of which depends on the similarity of the individual to study participants for whom the intervention was effective. You must never lose sight when attempting to generalize a practice supported by group research to an individual that some participants performed better, while others performed worse than the average participant. Do not be surprised if results are not replicated if your student or client differs substantially from the average group study participant.

Qualitative Research Approaches

The term qualitative research is an "umbrella" term that refers to a number of *descriptive research* approaches "that investigate the quality of relationships, activities, situations, or materials" (Fraenkel & Wallen, 2006, p. 430). Brantlinger, Jimenez, Klingner, Pugach, and Richardson (2005) define qualitative research as "a systematic approach to understanding qualities, or the essential nature, of a phenomenon within a particular context" (p. 195). A quantitative analysis of outcome measures is typically not of interest to qualitative researchers. The qualitative paradigm is discussed here in spite of its descriptive rather than experimental analysis of behavior due to what appears to be increased interest among some researchers who believe it is "ideal for phenomena that are patently complex and about which little is known with certainty" (Lancy, 1993, p. 9). Table 1.3 identifies and briefly describes 16 different qualitative research approaches that Brantlinger et al. place under the qualitative research paradigm. Of the 16 approaches, three have particular prominence among educational and clinical researchers who conduct qualitative research studies: case study, ethnography, and phenomenology. The *case study* approach entails an in-depth and detailed description of one or more cases (individuals, events, activities, or processes), while *ethnography* refers to the study of culture, defined as "the customary beliefs, social forms, and material traits of a racial, religious, or social group" (*Merriam-Webster Online Dictionary*, 2008), in which the investigator unobtrusively observes people in their natural setting without an attempt to influence their behavior or the event. Sometimes confused with ethnography, *phenomenology* is the study of people's reactions and perceptions of a particular event or situation. For a more in-depth discussion of these and other qualitative research approaches, see Glasser and Strauss (1967), Lincoln and Guba (1985), or Lancy (1993).

Common Characteristics

Qualitative research approaches share a number of common characteristics, not least of which is a desire to provide a detailed, in-depth description of the case or phenomena under study. Data are collected using several methods, including direct observation in which the investigator's role is that of a "participant-observer" in the natural environment, with neither an interest nor attempt to influence the person or event being observed. As a participant-observer the researcher takes field notes, sometimes referred to as "reflective notes," that are intended to capture the "essence" or "themes" of the observations. Other data-collection techniques include audio and video recordings that are summarized and presented in written narratives. Interviews and questionnaires are important data-collection instruments used in qualitative research. In terms of these two data-collection tools and their use in

Table 1.3 Types and Descriptions of Qualitative Research

Case study—exploration of a bounded system (group, individual, setting, event, phenomenon, process); can include autobiography and biography.

Collective case study—a study that takes place in multiple sites or includes personalized stories of several similar (or distinctive) individuals.

Enthnography—description/interpretation of a cultural or social group or system; typically includes observations, interviews, and document analysis.

Action research—researcher brings ideas for practice to fieldwork to have an impact on the setting/participants while collecting data.

Collaborative action research—researcher and practitioner share ideas about how to change practice and work together to modify a situation as well as collect information for a study.

Grounded theory—research done to generate or discover a general theory or abstract analytical hunch based on study of phenomena in a particular situation(s).

Phenomenology—studies the meanings people make of their lived experiences.

Symbolic interactionism—studies interpretive processes used by persons dealing with material and social situations.

Narrative research—collection of personal narratives; based on recognition that people are storytellers who lead storied lives.

Life (oral) history—extensive interviews with individuals to collect first person narratives about their lives or events in which they participated.

Quasi-life-history research—encouraging participants to recall and reflect on earlier as well as current meaningful occurrences in their lives.

Interpretive research—used synonymously with "qualitative work" and/or to refer to research framed within certain (critical, feminist, disability study, critical race) theories.

Content analysis—close inspection of text(s) to understand themes or perspectives (also refers to the analysis stage of qualitative studies).

Conversational analysis—studying interactional situations, structure of talk, and communicative exchanges; includes recording facial expressions, gestures, speed or hesitancy of speech, and tone of voice.

Discourse analysis—deconstructs common sense textual meanings; identifies meanings that undergird normative ways of conceptualizing and discussing phenomena.

Ideological critique—discourse analysis that assumes political meanings (power disparities) or ideologies are embedded in, and infused through, all discourses, institutions, and social practices.

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phenomenology, Fraenkel and Wallen (2006) describe the role of the researcher as one who "extracts what he or she considers to be relevant statements from each subject's description of the phenomenon and then clusters these statements into themes. He or she then integrates these themes into a narrative description of the phenomenon" (p. 437). Unlike the group study approach in which hypotheses are formulated prior to conducting a study to test a theory, known as a *deductive analysis* approach (i.e., general to specific), researchers who use a qualitative study approach collect data and describe themes or trends in the data without offering a theory, an approach known as *inductive analysis* (i.e., specific to general). In this regard, qualitative and single subject research studies are similar. A critical difference between qualitative and quantitative research approaches is, as Brantlinger et al. (2005) states, "Qualitative research is not done for the purposes of generalization but rather to produce *evidence* based on the exploration of specific contexts and particular individuals" (p. 203). If this is in fact how qualitative researchers view their approach, we as consumers of research must ask the question, "How can qualitative research findings support evidence-based practice if they can not be generalized beyond the case studied?"

Data Analysis, Reliability, and Validity Issues

The issue of credibility and trustworthiness of research findings is central to practitioners using promising, if not best practices in their service to students and clients and their families. Guidelines for evaluating the credibility of qualitative research studies have been developed by Brantlinger et al. (2005) and are presented in Table 1.4. These measures are how qualitative

Table 1.4 Credibility Measures for Qualitative Research

Triangulation—search for convergence of, or consistency among, evidence from multiple and varied daily sources (observations/interviews; one participant & another; interviews/documents).

- *Data triangulation*—use of varied data sources in a study.
- *Investigator triangulation*—use of several researchers, evaluators, peer debriefers.
- *Theory triangulation*—use of multiple perspectives to interpret a single set of data.
- *Methodological triangulation*—use of multiple methods to study a single problem.

Disconfirming evidence—after establishing preliminary themes/categories, the researcher looks for evidence inconsistent with these themes (outliers); also known as negative or discrepant case analysis.

Researcher reflexivity—researchers attempt to understand and self-disclose their assumptions, beliefs, values, and biases (i.e., being forthright about position/perspective).

Member checks—having participants review and confirm the accuracy (or inaccuracy) of interview transcriptions or observational field notes.

- *First level*—taking transcriptions to participants prior to analyses and interpretations of results.
- *Second level*—taking analyses and interpretations of data to participants (prior to publication) for validation of (or support for) researchers' conclusions.

Collaborative work—involving multiple researchers in designing a study or concurring about conclusions to ensure that analyses and interpretations are not idiosyncratic and/or biased; could involve interrater reliability checks on the observations made or the coding of data. (The notion that persons working together will get reliable results is dependent on the "truth claim" assumption that one can get accurate descriptions of situational realities.)

External auditors—using outsiders (to the research) to examine if, and confirm that, a researcher's inferences are logical and grounded in findings.

Peer debriefing—having a colleague or someone familiar with phenomena being studied review and provide critical feedback on descriptions, analyses, and interpretations or a study's results.

Audit trail—keeping track of interviews conducted and/or specific times and dates spent observing as well as who was observed on each occasion; used to document and substantiate that sufficient time was spent in the field to claim dependable and confirmable results.

Prolonged field engagement—repeated, substantive observations; multiple, in-depth interviews; inspection of a range of relevant documents; thick description validates the study's soundness.

Thick, detailed description—reporting sufficient quotes and field note descriptions to provide evidence for researchers' interpretations and conclusions.

Particularizability—documenting cases with thick description so that readers can determine the degree of transferability to their own situations.

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researchers address the validity and reliability of information in their research reports, but the authors caution against "using credibility measures as a checklist in a rigid and unreflective way," and, although they "encourage" researchers to use credibility measures, "they believe that authors who succinctly clarify the methods used and the rationale for them can convey that their reports are reliable and worthy of attention without alluding to credibility measures" (pp. 200–201). As you may have deduced from the quotes cited (e.g., "extracts what he or she considers relevant"), the primary criticism of qualitative research approaches is their lack of objectivity. A common characteristic of qualitative studies is the position of the researcher as an "insider" who has close personal contact with participants and who is both the data collector and data analyst. Brantlinger et al. acknowledge that they (qualitative researchers) are "the instrument" in their research and that "To do qualitative work well (be *valid* instruments), we must have experience related to our research focus, be well read, knowledgeable, analytical, reflective, and introspective" (p. 197). If true, the position of the qualitative researcher raises concerns because of the subjectivity of the data collected and reported,

which in turn influences the validity and reliability of findings since observational safeguards (e.g., independent observations) are rare. This lack of reliability of measurement alone is a major threat to the internal validity of findings, a confounding known as instrumentation (see Chapter 5 and Chapter 7 for detailed information on threats to internal validity and reliability of measurement). The use of field notes, narrative descriptions, and the freedom of investigators to "consider what is relevant" all signal a method that is prone to subjectivity and findings that would be difficult, if not impossible, to replicate. Replication, as previously noted, is at the heart of the scientific method. If replication of a study's findings has not been attempted or not been achieved those findings cannot be considered trustworthy or valid. So, what does qualitative research offer to the science of human behavior? In spite of concerns over subjectivity and lack of replication, qualitative studies can and do provide detailed descriptions of behavior under natural conditions that could subsequently lead to asking research questions, or testing research hypotheses, that employ more objective, quantitative research approaches.

Single Subject Research Approach

Single subject research methodology has a long tradition in the behavioral sciences. Sidman (1960) first described this research approach in his seminal book, *Tactics of Scientific Research: Evaluating Experimental Data in Psychology*, which exemplified its application within the context of basic experimental psychology research. In 1968, Baer, Wolf, and Risley elaborated on single subject research methodology and how it could be used in applied research to evaluate intervention effectiveness with individuals. Since that time numerous articles, chapters, and books have been written describing single subject research methodology and its use in a number of disciplines, including psychology (Bailey & Burch, 2002; Barlow & Hersen, 1984; Johnston & Pennypacker, 1993; Kazdin, 1998; Kratochwill & Levin, 1992; Skinner, 2004), special education (Gast, 2005; Kennedy, 2005; Richards, Taylor, Ramasamy, & Richards, 1999; Tawney & Gast, 1984), "helping professions" (Bloom & Fischer, 1982), literacy education (Neuman & McCormick, 1995), communication sciences (McReynolds & Kearns, 1983; Schlosser, 2003), and therapeutic recreation (Dattilo, Gast, Loy, & Malley, 2000). As Horner et al. (2005) pointed out, over 45 professional journals publish single subject research design studies. A common misconception about single subject research methodology is that it is appropriate only if you subscribe to a behavioral psychology model, which is incorrect. Although it is based in operant conditioning, applied behavior analysis, and social learning theory, interventions based in other theoretical models may be evaluated within the context of a single subject research design. In this section the basic parameters of single subject research methodology are overviewed as a means of comparison with previously described research approaches. Quality indicators for evaluating single subject research studies have been developed by Horner et al. and are presented in Table 1.5. The topics introduced in this section, including criteria for evaluating supportive evidence of a practice, are discussed in detail in the chapters that follow.

Characteristics of Single Subject Research Design

In spite of its name, single subject (or single case) research design, it is important to understand that this research approach is *not* a case study approach in which there is only one participant whose behavior is described, in detail, in written narrative, based on primary data collected using qualitative research techniques (e.g., field notes, interviews). Single subject research design is a quantitative experimental research approach in which study participants

Table 1.5 Quality Indicators Within Single-Subject Research

Description of Participants and Setting
- Participants are described with sufficient detail to allow others to select individual with similar characteristics (e.g., age, gender, disability, diagnosis).
- The process for selecting participants is described with replicable precision.
- Critical features of the physical setting are described with sufficient precision to allow replication.

Dependent Variable
- Dependent variables are described with operational precision.
- Each dependent variable is measured with a procedure that generates a quantifiable index.
- Measurement of the dependent variable is valid and described with replicable precision.
- Dependent variables are measured repeatedly over time.
- Data are collected on the reliability or interobserver agreement associated with each dependent variable, and IOA levels meet minimal standards (e.g., IOA = 80%; Kappa = 60%).

Independent Variable
- Independent variable is described with replicable precision.
- Independent variable is systematically manipulated and under the control of the experimenter.
- Overt measurement of the fidelity of implementation for the independent variable is highly desirable.

Baseline
- The majority of single-subject research studies will include a baseline phase that provides repeated measurement of a dependent variable and establishes a pattern of responding that can be used to predict the pattern of future performance, if introduction or manipulation of the independent variable did not occur.
- Baseline conditions are described with replicable precision.

Experimental Control/Internal Validity
- The design provides at least three demonstrations of experimental effect at three different points in time.
- The design controls for common threats to internal validity (e.g., permits elimination of rival hypotheses).
- The results document a pattern that demonstrates experimental control.

External Validity
- Experimental effects are replicated across participants, settings, or materials to establish external validity.

Social Validity
- The dependent variable is socially important.
- The magnitude of change in the dependent variable resulting from the intervention is socially important.
- Implementation of the independent variable is practical and cost effective.
- Social validity is enhanced by implementation of the independent variable over extended time periods, by typical intervention agents, in typical physical and social contexts.

Source: Horner et al. (2005). Copyright by Society for the Experimental Analysis of Behavior, Inc. Reproduced by permission.

serve as their own control, a principle known as "*baseline logic*" (Sidman, 1960). In single subject design studies each participant is exposed to both a "control" condition, known as baseline, and an intervention condition. The target behavior is repeatedly measured within the context of one of several research designs that evaluate and control for threats to internal validity. Depending on the research design used, baseline (A) and intervention (B) conditions are slowly alternated across time (e.g., A-B-A-B or withdrawal design), or the intervention condition is introduced in a time-lagged fashion across several behaviors (conditions or participants). Return to a previously introduced condition or introduction of a new condition to a new behavior (condition or participant) occurs only after data stability is evident. Data for individual participants are presented on a line graph for each participant and decisions to maintain or change the current condition are made in accordance with visual-analysis guidelines (see Chapter 9 for information on visual-analysis guidelines). Baseline logic is very different from group design logic in which similar or matched participants are assigned to one of two or more study conditions (control or intervention) based on pretest data and, unlike single subject studies, not all participants are exposed to the intervention. At some specified time in the

future, not necessarily when participants have reached some pre-established performance criteria, posttest data are collected and analyzed using statistical methods comparing the average performance of participants assigned to one condition to the average performance of participants assigned to other conditions. Where group research data are analyzed using statistical procedures, single subject research data are analyzed primarily using visual-analysis guidelines in which graphed data levels, trends, and stability are reported for each study participant. Descriptive statistics (mean, median, mode, range) are also used to summarize results. Single subject research designs and visual analysis of graphic data for individual participants make them ideal for applied researchers and practitioners who are interested in answering research questions and/or evaluating interventions designed to change the behavior of individuals.

Controlling Threats to Internal Validity

Regardless of the research approach, alternative explanations must be ruled out for there to be confidence that the independent variable was responsible for a study's findings. The extent to which researchers evaluate and control for threats to internal validity will determine the level of confidence we can have in their results. In single subject research studies a participant's behavior is repeatedly measured under at least two experimental conditions, baseline and intervention, using direct observational recording procedures. To ensure data-collection objectivity, independent observers periodically check the accuracy of measures using the same definitions and recording procedures used by the primary observer. These data are typically reported as percentage of interobserver agreement. It is also important that experimental condition procedures (baseline and intervention) be consistently followed. To ensure procedural fidelity, an independent observer collects data on "key" procedural variables (e.g., securing student attention, waiting 5 s for participant's response, delivering correct consequences) and reports the percentage of time *each* variable is correctly followed. To evaluate and control for outside or "extra-experimental" influences and the passage of time that may be responsible for observed changes in behavior, single subject design researchers systematically (a) alternate baseline and intervention conditions (withdrawal, reversal design, multitreatment design, alternating treatments design) or (b) stagger the introduction of the intervention across three or more behaviors, conditions or participants (multiple baseline design, multiple probe design) that are functionally independent but amenable to the same intervention. Other strategies are used to evaluate and control for the influence of participants' awareness of being observed, repeated exposure to test conditions, their withdrawal from a study, variability in their performance, and performance carryover effects when moving from one condition to another. In determining the supportive evidence for a practice a single subject design study must address and report the extent to which threats to internal validity were controlled. Subsequently, independent researchers will need to replicate results of earlier studies in order to extend the generality of findings. Through replication "the scientific method is self-correcting" (Harry, 2006, p. 44).

Research Approaches and Generalization to the Individual

In education and clinical practice, educators, psychologists, speech/language pathologists, occupational, recreation, and physical therapists are expected to evaluate the adequacy of their efforts by measuring changes in each student's or client's behavior over the duration of their programs. While many, if not most, of these professionals are interested in individual performance, other practitioners, as well as administrators and some researchers, will evaluate the adequacy of their system-change efforts (e.g., curriculum revisions, school-wide

discipline policy) by focusing on the performance of the group. Many of these professionals, however, will identify those individuals who respond poorly to the system change and modify the program in some way with the intention of bringing about positive change in all group members. There are few occasions, if ever, when it would be acceptable for an educator or clinician to ignore the needs of an individual who has failed to benefit from the first instructional program or treatment attempted. Professional ethics across disciplines dictates an active and concerted effort by practitioners and applied researchers to identify an intervention that will succeed in benefiting each student, client, or research participant, regardless of the number of attempts it may take to find such an intervention. This position is fundamental to applied behavior analysis research as described by Baer et al. (1968). So, what do research reports (i.e., published journal articles) using these three research approaches have to say to practitioners wanting to positively change behavior of their students or clients?

Group Research Approach

Group design studies, regardless of whether they are experimental, quasi-experimental, or correlational, are interested in the average performance of group members, with some individuals assigned to the control group that does not receive the intervention, while other individuals are assigned to ineffective or inferior intervention groups. Even for those individuals assigned to the group in which an intervention was determined to be effective, based on achieving a statistical significance level of $p < 0.05$, the intervention was ineffective for some individuals in the group. That is, group research findings overestimate their generality since not all individuals respond in the same way to the independent variable. In a similar vein some group study participants perform better than the average participant, thus underestimating the impact of the independent variable. If, however, your interest were to evaluate a curriculum or policy change and its effect on group performance, a group research approach would be better suited for answering your research questions or testing your hypotheses.

Concerns with the group research approach, relative to study participants and generalization of findings to other individuals, include ethical issues when study participants do not benefit from their participation. Irrespective of the time lost, introducing an effective intervention after the study has concluded can address this concern, a practice that conscientious group researchers are following. Less easily addressed by the group research approach for the scientist-practitioner is the practical problem of identifying a sufficiently large sample to make any statistical test of findings meaningful. For those of us interested in studying "low-incidence" populations it is nearly impossible to find a large enough population in a single site, thus precluding use of a group research design. As previously discussed, even when a large sample is available, inter-subject variability and a failure to analyze and report individual characteristics decreases the generality of findings unless the individual is similar to individuals who responded positively to the intervention.

Qualitative Research Approaches

Qualitative research approaches attempt to provide an in-depth descriptive report of a single individual, event, or activity without proclaiming that their findings generalize beyond the case studied (Brantlinger et al., 2005). In addition to providing an insightful account of the target case, qualitative research reports can be of value to researchers and practitioners by serving as a source for generating research questions and hypotheses that can be addressed with more objective quantitative research approaches. Practitioner findings from qualitative studies

provide minimal, if any, support for a practice since there is no attempt to isolate causes of an observed behavior change, and level of subjectivity in observations, data analyses, and reporting.

Single Subject Design Approach

Single subject research methodology is a "low-inference model" that is based on inductive reasoning and is ideal for the scientist-practitioner. The individual is of paramount importance as evidenced by the in-depth and detailed descriptions of individual participants and their performance in published research reports. Since individual data are presented it is possible, as a consumer of research, to analyze independently the effect an intervention has on each participant. If there is inter-subject variability, it is possible to analyze individual characteristics that may account for performance differences. For those participants for whom the initial intervention was not effective, applied researchers will continue to search for an effective intervention while still demonstrating experimental control. The dynamic nature of the research methodology allows the researcher to respond to individual differences, and in so doing identify intervention modifications or alternatives that may prove effective for other individuals for whom the original intervention failed. Because of its emphasis on providing a detailed description of study participants and procedures, objectivity in measurement, evaluation and control of alternative explanations for findings, individual visual presentation and analysis of data, and systematic replication of findings, single subject research studies provide an important evidence base for supporting a practice.

Summary

There are a number of research approaches available to the scientist-practitioner who chooses to add evidence in support of a particular practice he or she is currently using or is considering using. As a contributor to research evidence, it is important to choose the appropriate research methodology that best answers the research question. Group research methodology is appropriate and best suited for testing hypotheses when your interest is in the average performance of a group of individuals, but it will have limited generality to individuals who differ from those for whom the intervention was effective. Unfortunately for practitioners who are consumers and evaluators of group design research, sufficient details are seldom provided on individual participants that would allow them to make an informed decision as to the likelihood of their student or client responding positively to the intervention studied. Qualitative research approaches (e.g., case study, ethnography, phenomenology) may be appropriate if your interest is in an in-depth qualitative (as opposed to quantitative) descriptive report of an individual, activity, or event. Studies using this research approach make no attempt to intervene, control for common threats to internal validity, or generalize findings beyond the case studied. The single subject research approach focuses on individual performance and permits practitioners and researchers to independently evaluate the merits of a study or a series of studies since all primary data are presented on all participants in graphic displays and tables. In accordance with scientific method principles, sufficient detail is typically presented in single subject research reports to permit replication by independent researchers. It is through such replication efforts that the generality of findings of a single study is established and evidence generated in support of an intervention. In the chapters that follow we have attempted to provide sufficient detail on the parameters of single subject research methodology to allow you to objectively evaluate and conduct single subject research studies. Through your efforts and the efforts of other applied researchers it is possible to advance our understanding of human

behavior and add evidence in support of effective practices. To this end, scientist-practitioners must disseminate their research findings in professional journals, at professional conferences, and during clinic or school inservices.

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Writing Tasks: Literature Reviews, Research Proposals, and Final Reports

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Variations of Multiple Baseline Designs and Combination Designs

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Statistics and Single Subject Research Methodology

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