Chapter 3
Science and its Role in the Study of Behavior & Autism

Key Terms:

Science	Replication	Behavioral
Determinism	Philosophic doubt	Analytic
Empiricism	Pseudoscience	Technological
Parsimony	Manipulation	Effective
Experimentation	Applied	Generality
Conceptually Systematic		

Key Points:

* Factual understanding of events and processes can be attained as a result of scientific investigation.
* Applications of science have led to extraordinary improvements in human behavior.
* A scientific approach relies upon the application of specific principles or attitudes.
* Behavior, when viewed through a natural science approach and subject to the properties of science, is susceptible to external influence.

Information: Friend or Foe?

We live in an age of information, where words, images and sounds are only a mouse click away. Advances in **science**, medicine and industry are disseminated to the public in a fraction of the time of past eras. In short, our modern world is one in which news travels quickly. *Very* quickly.

This new age of information access has shifted the paradigm by allowing people of varying educational and socioeconomic levels to access knowledge that was once reserved for highly trained experts. As a result, people have become well-informed advocates for their own causes. They are learning the right questions to ask at the doctor's office and are less likely to be taken advantage of by a mechanic. They are also learning how to better deal with problems they encounter in the education and care of their children – which continues to bring me to the conditions that led me to update this manual.

When a child is diagnosed with a disability (including autism), there is an added urgency for information. Families are often hurtled at full speed into a world of technical jargon, an army of professionals with many philosophical perspectives, a whirlwind of opinions from family and friends and an avalanche of paperwork. At the center of this firestorm is the child.

Parents find themselves desperate for answers to questions such as: "What will her life be like?" "Will she at least be happy?" "Who can help us do the best we can for our child?" Caring and committed teachers and professionals feel a similar desire for answers, because they share the responsibility of providing the child with the skills and experiences that will lead to the best quality of life possible. As a result, a furious search begins to gather as much information as possible, from as many sources as possible.

In the midst of this, there is a caveat: *while we live in an age of information, it includes both good* ***and bad*** *information.* There is an adage that one can possess too little information to be effective, but just enough to be dangerous. And, while there are devices that filter offensive material from entering a home or computer screen, there are none that block information that is bogus, or that could cause the investment of countless hours and endless dollars in ineffective treatments.

A consequence of unlimited information access is that many different paths of action can be presented, and to the untrained eye, all are equally valid. Science ultimately reveals the correct paths for effective treatment, but the Internet provides so many choices that parents and professionals are often too confused to look for the right markers.

Science and the Study of Human Behavior

Few areas share the breadth and scope of the study of human behavior. At every level, each of us has some experience with or opinion on the topic. Perhaps it is because of the integral part behavior plays in the life of every human being that we have spent eons trying to understand what makes us do the things we do. At times, it seems like everyone is a self-proclaimed expert in human behavior, or at least has an opinion that they will argue.

As understandable as this may be, imagine if everyone held the same "lay expert" attitude in areas of medicine or physics. We would still hold faulty notions such as the flatness of the earth, or the idea that our health is determined and controlled by "humours" or even by the position of the stars and planets at our birth.

But because we have not ignored science, our world is a much better place. We now cure once-fatal diseases. We have developed new vaccines, such as for the Coronavirus. We know how to replace organs. We are exploring the outer reaches of the solar system. Science has the power to continually point us toward a greater understanding about our world, and our place in it. Shouldn't we use the same principles of scientific inquiry to enhance our understanding of human behavior?

> *"If we are to use the methods of science in the field of human affairs, we must assume behavior is lawful and determined. We must expect to discover what a man does is the result of specifiable conditions and that once these conditions have been discovered, we can anticipate and to some extent determine his actions"*
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> *(Skinner, 1953, p. 6).*

This statement in *Science and Human Behavior* (Skinner, 1953) suggests the application of scientific methods to the analysis and prediction of human behavior. And yet, the belief that human behavior is primarily a product of environmental conditions or contingencies and that these natural phenomena can be best understood through scientific investigation is not widely accepted. The psychological and educational communities continue to rely heavily on psychodynamic theories that place the origin of human action ultimately in the mind, the personality, or the will of the individual.

In the past century, the true science behind behavior has grown quite robust. There have been incredible advances in the understanding, measurement, prediction, and ability to change the behaviors of all sorts of living beings, including humans.

By approaching human behavior as a natural science – as a lawful, predictable, observable, measurable and malleable subject – we have been able to develop a great body of technology to shape and change people's lives for the better. Behavior has been largely demystified at the clinical level, and this has given rise to extremely effective interventions for problem behaviors, as well as a roadmap for teaching new behaviors more quickly, and to higher levels of performance. Both applications are extremely relevant in our current quest to provide intervention services for individuals with autism.

In this chapter, the principles of science will be reviewed, including how they can and should be used to understand the difference between proven, effective techniques for teaching children with autism and those that are ineffective or marginally effective at best.

A scientific framework will also be provided upon which the particulars of effective interventions can be evaluated and layered. Because the approaches presented in this manual rely upon the basic principles of science, progressing without this discussion might restrict the reader's perspective regarding effective autism intervention.

Section A ~ Attitudes of Science

Science is the organized body of knowledge about the natural world that is derived from a set of logical and observable methods. These methods provide for systematic observation of natural phenomena so that we can better understand the world in which we live. Explanation of natural phenomena typically takes the form of a *theory* that tries to account for how things work, how natural events occur in predictable patterns, or why phenomena appear to us as they do.

Our world has always been shaped by science, even when methods of inquiry were quite rudimentary. As inquisitive beings, it has always been important for us to understand how things work. In prehistoric times, science probably consisted of simple experimentation regarding which materials made the best tools, or which substances were worthy of eating. An idea came to mind, it was tested, and the results were somehow passed along to others. Imagine being the first person to eat an egg! In many ways, science, at its very foundation, is a much more developed approach to these same early "experiments."

The state of science really did not experience vast growth before the classical era of Greece. There were certainly advances in lexicology, or the development of recorded language, and there were obvious advances in our ancestors' abilities to understand numbers, both of which play an integral part in the development of science. But there was no real method or systematic way to approach problems until sometime around the birth of the classical era.

The Greeks introduced the world to a new way of thinking. The age of rationalism dawned with the argument that the complexities of the universe could be explained through reason. Since then, the application of logic and reason to unraveling the mysteries of life has been highly refined. Using sophisticated tools for observation and measurement, along with rigorous methodological models, scientists can turn fiction into fact. Unexplained phenomena that have perplexed humans throughout history are being resolved, or at least accounted for.

Human behavior, including aberrant behavior (like that often associated with autism), is no exception. For this reason, the principles of science can and should be used to understand the difference between proven, effective techniques for teaching children with autism and those that are ineffective or marginally effective at best.

We can get a better sense of what science is by considering its properties. It is generally agreed that science possesses the qualities of **determinism**, **empiricism**, and **parsimony**. Additionally, science always involves the **experimentation** and **replication** of natural phenomena and adopts an attitude of **philosophic doubt** or skepticism about its findings.

> Science is first of all a set of attitudes.
>
> *Skinner, 1953, p.12*

Determinism is a philosophical belief that all events are determined by natural (or mechanistic) causes. In other words, all natural phenomena occur as a result of other environmental events and are related in systematic ways. Determinism also holds that this interplay of natural phenomena occurs in a lawful and orderly fashion. This position – that things don't happen in a haphazard manner – can't be proved or disproved. It is, however, central to scientific investigation.

In the case of human behavior, determinism explains an individual's behavioral response to any given situation as the cumulative result of a myriad of environmental events or factors at that moment, and in his or her past. It does not, however, permit one to enter a discussion of how an individual's free will

governs how he or she acts, or how the individual simply "makes up his mind" to do something. Determinism does not allow for such unknowable or supernatural explanations for human behavior.

At times, this can be a difficult pill to swallow. Humans are very proud creatures, and the thought that we are not in complete control of our destiny can be very disconcerting. This sense of egocentrism has been one of the major stumbling blocks to the acceptance of a purely scientific investigation of human behavior.

In other words,

Determinism assumes that our behavior is the result of events that occur in our environment. By identifying these events, we can change the future occurrence of the behavior. It can also be helpful to think of Determinism as "if/then" statements. If a specific antecedent occurs in the environment, then a specific behavior is likely to occur.

According to the theory of **empiricism**, all knowledge is gained ultimately through the senses. While philosophical argument has long struggled with this notion, the natural sciences drew heavily on empiricism in the development of the scientific method and its dependence on objective observation, experimentation, and precise measurement.

When it comes to human behavior, science requires that its phenomena be observable, measurable, and subject to manipulation. Most of what we do in our everyday lives, for example, can be easily accepted as behaviors that can be observed, measured, and changed.

Internal or private events, such as emotions, feelings, intuitions, thoughts, values, and beliefs, may seem at first glance to fall outside the parameters of empirical phenomena. These, our most personal and private "possessions," somehow seem exempt from the cold eye of science. Granted, these behaviors are less obvious and do not always lend themselves well to the standard methods of measurement and manipulation. They do, however, meet the requirements of empirical observation and measurement. They can be observed when one considers that this observation is simply limited to the person doing the thinking, feeling, or believing. The observer can also quantify the rate and magnitude of thoughts or feelings. In addition, the notion that we can alter the thoughts, feelings and beliefs of others is a fundamental assumption without which the entire field of clinical psychology would find itself without purpose.

In other words,

Empiricism is the primary rule in behavior analysis. It involves the objective observation and measurement of behavior. It is objective pertaining to a clear and precise description of what a behavior looks like. The opposite of objective would be subjective, where it is up to the clinician's own interpretation of what the behavior looks like. Measurable looks at being able to collect data on the behavior of interest (by how often it occurs, how long it occurs, etc.) to determine if a change in the behavior occurred.

Personal beliefs are set aside.

Parsimony has its origin in medieval philosophy. An English monk and philosopher, William of Ockham (ca. 1285-1349) coined the phrase *"Pluralitas non est ponenda sine neccisitate"* or "plurality should not be posited without necessity." Also known as *Ockham's Razor* (think of it as a tool for "cutting away" that which is not likely), parsimony requires that the pursuit of simpler explanations for natural phenomena occur before looking to more complex or abstract reasons.

As it developed, the academic community within the natural sciences embraced the principle of parsimony as another of science's defining attributes. Simply stated, science requires that all simple, logical explanations be ruled out experimentally before more complex or abstract explanations are considered.

Carl Sagan described a popular example of the need for parsimony in his book *The Demon-Haunted World: Science as a Candle in the Dark*. Sagan observed how the media and general public seized upon the phenomenon of "crop circles" as evidence of nocturnal visitation by creatures from outer space. A more "parsimonious" investigation, however, revealed that the vast majority (if not all) of these occurrences were the product of very human pranksters.

A science-based view of human behavior utilizes the principle of parsimony in its analytic processes. Rather than place the origin of human action in the unobservable, metaphysical province of the "mind," a scientific approach to behavior looks to simpler, more-observable environmental events around or within the individual.

In other words,

Parsimony is considering a simpler or logical explanation which requires the fewest number of assumptions and irrelevant variables.

As Dr. Theodore Woodward said, "If you hear hoofbeats, think horse – not zebra."

For example, when Sam gets off the bus and walks into school, he cries. His teacher gives him time on the iPad to calm him down before the day starts. Sam just started using pictures to communicate and can't tell his teacher what is wrong. The teacher thinks it could be for a couple different reasons including there is a peer on Sam's bus who makes fun of him, or he likes the bus and doesn't want to get off.

Using the law of parsimony, the correct response would be to determine if Sam's crying is because he knows if he cries, he gets the iPad. This is a much simpler explanation and avoids the use of abstract concepts.

The testing of scientific theories or hypotheses developed to describe the natural world eventually must involve systematic manipulation of the specific variable(s) involved. Through **experimentation**, direct, empirical observation of a natural event will allow us to begin to better understand the phenomenon. This gives us the capability to describe it in more precise and systematic language and hopefully, to begin to see that the phenomenon can be linked to other natural phenomena according to some regular pattern.

Correlations between natural events (i.e., the fact that two separate phenomena consistently occur in a regular temporal sequence) are what scientists love to discover, as they suggest the existence of a causal or functional relation that can be tested. This leads scientists to formulate a hypothesis that a) postulates the existence of a functional relation between the two events, and b) predicts the future probability of that event occurring in the presence of the correlated event.

Proving the hypothesis, or the existence of a functional relation, requires scientific manipulation of the variables involved. Experiments are designed to systematically manipulate the occurrence of the two events in question while eliminating or controlling the effects of other naturally occurring variables. If it can be shown that one event can be reliably made to happen solely due to the presence of the other correlated event, then a *functional relation* between the two is said to exist.

In other words,

Experimentation is testing your theory of why a behavior occurs.

For example…
There is a student in your classroom who is preoccupied with shiny doorknobs. Whenever you walk down the hall and come to a certain door, the student always drops to the floor. Knowing this student's fascination with shiny doorknobs, your hypothesis for why he drops to the floor in front of the same place in the hallway is because there is a shiny doorknob on the door.

To test your hypothesis, you place a child safety cap on the doorknob to cover it up. The next several times you take the student by this door he no longer drops to the floor. To further test your hypothesis, you remove the child safety cap and again, take the student for walks past the door. Sure enough, he drops to the floor every time in front of the door. Your final step to test your hypothesis is to place the child safety cap back on the doorknob, and the student no longer drops to the floor.

Being able to withdraw and apply an intervention (such as the child safety cap), you can demonstrate experimental control by manipulating the variables (doorknob) and show that it is your intervention that has a direct effect on the student's behavior.

Rigorous scientific pursuit does not cease at the single study but requires **replication** to strengthen the case. Even if the single study is sound in its design and the results are highly favorable, these findings are not sufficient to say one has proved an intervention to be effective. It is not until the same pattern of results is replicated across many other studies that scientists become convinced of the results. Experiments are repeated to ensure that the natural phenomenon in question can again be caused to occur in the presence of the correlated event. It is through replication of the experiment that we determine the reliability of our findings, as well as discover our mistakes (Cooper, Heron, & Heward, 2020).

Experiments to test hypotheses concerning complex human behaviors are tricky to design, but not impossible. The wealth of research in the areas of functional analysis, skill instruction, behavior reduction, etc. conducted over the past several decades has made it abundantly clear we can effectively apply scientific methodology to human behavior. This is seen most obviously in the treatment of severe problem behavior. For example, the ability to analyze a child's behavior to accurately determine a

functional relation between it and socially mediated variables such as attention or avoidance has resulted in the design of treatment programs of unparalleled efficacy.

In other words,

Replication is having others implement your intervention and see if they get the same results as you did.

While science attempts to explain how our world works, it does not view its knowledge as final or absolute. The attitude of **philosophic doubt**, or skepticism, requires that facts be viewed as tentative and subject to further questioning and experimentation.

Scientific knowledge undergoes continued development and refinement as the testing of theory progresses. The philosopher Karl Popper, in his book *The Logic of Scientific Discovery*, remarked that the unique characteristic of all scientific theories is that they are "capable of being tested by experience." Popper goes on to state that the more tests a theory undergoes, the greater its empirical content and the greater its general acceptance. Moreover, well-tested theories spawn new investigation, new theories, and the development of technologies that apply theoretical knowledge to improve our lives.

In other words,

Philosophic doubt requires us to always question what is regarded as fact. Philosophic doubt is why we test our own assumptions, hypotheses, and underlying beliefs; to verify what we know or to reveal new findings.

Science and Autism

Considering the realm of autism and the plethora of current theories and treatment options available to clinicians and parents, it is interesting to note the relative lack of well-tested theories. Theories about the causes of autism, for example, range from allergies to sensory integration deficits to early childhood vaccinations as discussed earlier. But when held up to the standard of systematic manipulation of empirical phenomenon, these and many other "theories" are generally viewed by the scientific community as speculation or, at best, unproven.

The autism treatment technology that has emerged from the past 60 years of scientific inquiry and experimentation has been shown to be highly effective and replicable across a wide spectrum of children affected by autism. Unfortunately, these methods are labor intensive and require a certain level of expertise among their practitioners.

As a result, the more popular theories of autism and their respective therapeutic methodologies are attractive to the uninformed public because they guarantee success with relatively low effort and limited training requirements for their implementers. Some quickly pounce upon these "magic bullet"

therapies. The long-term costs of selecting the quick fix, however, are the loss of critical early intervention time pursuing unproven methods and their generally poor outcomes. How do such interventions gain esteem?

> *An interesting debate has gone on… between those who think that all doctrines that smell of pseudoscience should be combated and those who believe that each issue should be judged on its own merits, but that the burden of proof should fall squarely on those who make the proposals. I find myself very much in the latter camp. I believe that the extraordinary should be pursued. But extraordinary claims require extraordinary evidence.*
>
> *~ Broca's Brain, by Carl Sagan*

Section B ~ Opponents of Science

Low effort and limited training requirements are the tip of the iceberg when it comes to reasons for choosing non-scientific approaches to autism intervention. Why would any person of sound reason turn their back on any approach that features the hallmarks of sound science, including built-in measures of effectiveness, replicability, procedural integrity, and the ability to concretely demonstrate the procedures responsible for the desired effect? Here are a few thoughts on why.

First, as stated, applying a scientifically sound approach typically involves both a significant amount of expertise and a high level of effort. Second, a scientific approach to learning, development, and disabilities (such as autism) places an emphasis on identifying and manipulating variables that are external to the person subject to intervention. This, in effect, removes the burden of the learning problem from the individual and places it upon those responsible for instruction and care.

Think of the potential ramifications of attributing a reading problem to an internal, unobservable state (dyslexia) that is the sole intellectual "baggage" of the person who fails to read. Because it is internal, educators could dodge their burden to teach the skill. Behavior analysts, on the other hand, use a scientific vantage point to look at the *external* variables surrounding the skill and its demonstration, or lack thereof. In this case, it is our burden to find a way to identify the contingencies that will allow the behavior to be shaped; therefore, behavior analysts take the stance that "the learner is never wrong." This example is only used as a means to explain the accountability that can be avoided by assuming an approach that is non-scientific. Attribution of problems to internal issues is one way to "explain away" problems so that we do not have to pursue an effortful intervention for which we may lack the necessary skills.

Another reason that people may steer away from scientific approaches is human pride. How can we be above laboratory animals if we are prone to follow the same rules of behavior? And what does a scientific view say about natural talents and gifts? People who excel in certain tasks tend to take pride in the notion that their success is the result of innate talent, something special and unique to them.

If such successes are reduced to behavioral terms such as reinforcement histories, prompting and opportunities for repetition, the uniqueness of their achievements seems to be lost. Unfortunately, people also fail to realize that a scientific account does not necessarily eliminate such phylogenic variables as genetics and natural characteristics.

A fourth reason has to do with the notion that our cultures have been shaped by mysticism and spirituality. While this is not an attempt to challenge personal beliefs, there are inherent problems encountered when one tries to use a rational, empirical approach to explain phenomena that many prefer to view as rooted in supernatural or mystical constructs. Historically, we have also turned to non-scientific accounts of human affairs to make the realities of life more bearable. Let's face it, when one considers all the variables that have a direct impact on the way we live our lives, reality can be a frightening proposition.

Science provides us with the ability to answer questions that have haunted us for years. At the same time, one also must perform a "gut check" to determine whether we really want to know the answers. Nineteenth century mathematician Henri Poincaire offered this supposition as he made the statement: "We also know how cruel the truth often is, and we wonder whether delusion is not more consoling."

Take for example, the notion of love. Who would ever want to reduce such a "magical" concept to quantifiable, observable, or manipulative terms? The same type of thinking pervades our perceptions of teaching and learning. In higher education, young teachers are often encouraged to place more emphasis on developing creative skills or the ability to entertain, rather than on developing scientific skills or the ability to design and evaluate teaching methods that are proven to be effective. Our mystical predispositions lead us to refer to the "art" of teaching, or to find teachers who will "unlock hearts and minds," rather than identify and teach discrete skills that will lead to advanced execution of complex skill repretoires.

A final challenge to scientists in the field of education or developmental disabilites is the proliferation of practitioners who capitalize on emotional vulnerability and even desperation embodied by many parents who care for their children and do not know where else to turn for help. Without science, it is relatively easy for an articulate person to sell his or her approach as a viable treatment option, regardless of any proven effect.

If we deny science, if we say that the symptoms of autism cannot be measured, or that there is no way (or need) to prove that an interevention is effective, then we open the door to accepting virtually any type of treatment. There are very intelligent people in the field who realize this, and who market their approaches on the basis of how they appeal to our emotions or value systems. Rather than rely upon hard evidence of treatment effects, they rely upon anecdotal information and market their services with an emphasis on value statements over fact.

There are also those who engage in "pseudoscience," or activities that are designed to appear scientific without meeting the rigor or basic qualities of true science. These professionals are much like the alchemists of old – using logic and terminology that is inventive and derivative of true science, but lacking in the application of its basic qualities, such as empiricism, systematic manipulation, philosophical doubt and parsimony. Their work may produce data, but the data cannot be achieved by others because there are no clearly defined or replicable parameters of the interventions themselves.

Section C - Suggestions

It is important to put forth some suggestions for identifying interventions that meet the requirements of science. These are the same guidelines that must be followed before a drug is brought to market, that govern medical treatment approaches, and that have led to refinements in basically every technology. They are based on the idea that interventions resulting in what seem like far-fetched claims should be supported by rigorous evidence.

In 1748, David Hume put forth the idea "A wise man…proportions his belief to the evidence" (p.73). This assertion was later revised by Carl Sagan to become perhaps the best-known rallying cry of skeptics everywhere: "Extraordinary claims require extraordinary evidence" (Sagan, 1979, p.100). This statement, from 1979's *Broca's Brain*, was part of a larger argument for studying what seem to be extraordinary claims, as opposed to merely dismissing them with a closed mind. When evaluating claims of treatment efficacy, or when trying to determine which course of action will yield the best results when working with a child with autism, my advice is to adopt a skepticism that will allow you to act objectively.

It is essential that one is skeptical when trying to decipher best practices from "flim-flam" – and we all know that the field of autism intervention is full of flim-flam. Skeptics are, by definition, required to maintain an open mind to new ideas, but simply cannot accept a claim as true without evidence. To quote Michael Shermer, a well known academician in scientific fields:

> *"Modern skepticism is embodied in the scientific method, which involves gathering data to test natural explanations for natural phenomena. A claim becomes factual when it is confirmed to such an extent that it would be reasonable to offer temporary agreement. But all facts in science are provisional and subject to challenge, and therefore skepticism is a method leading to provisional conclusions… The key to skepticism is to navigate the treacherous straits between 'know nothing' skepticism and 'anything goes' credulity by continuously and vigorously applying the methods of science"* (Shermer, 2002, p.16).

Science Versus Pseudoscience

There must be an attempt to look for a way to distinguish science from **pseudoscience**. Science shares several characteristics with history: they are both cumulative and progressive in that they continue to improve and refine knowledge of our world and our past, based on new observations and interpretations. Pseudo history and pseudoscience, if they change at all, change primarily for personal, political, or ideological reasons (Shermer, 2002).

The pursuit of real information in the face of pseudoscientific trends becomes a sort of wild goose chase for many who are not armed with the basic principles of scientific decision-making. Therefore, to make the differences between pseudoscience and real science clear, it is important to show how both have shaped our lives. Science is both cumulative and progressive, because useful ideas, features and facts remain intact and relevant, while non-useful or faulty ideas, features and fallacies are rejected. This takes place through the systematic confirmation or rejection of testable knowledge by those who apply scientific principles. As this process continues, our body of usable knowledge increases, while our paradigms shift to reflect this growth. Advances in physical and natural sciences, such as paleontology,

astronomy, physics, chemistry, and medicine, have occurred consistently and have instigated major changes in the way we understand our world.

Pseudoscience does not usually set into motion a paradigm shift. Advances in astrology, tarot reading, phrenology, pyramid power or colonic administration have not really occurred, let alone triggered any kind of mass change within a discipline. Why, then, do we continue to fail to employ skepticism (and its offspring, scientific inquiry) in our evaluations of pseudoscience within the realm of social sciences, such as education?

Here, more than in almost any other discipline, we find ourselves regularly faced with outrageous and unsubstantiated claims that make their way into the general knowledge base of practitioners and consumers. In medicine, there are certainly proponents of homeopathic or alternative treatments, but these are seen as "the fringe," operating largely outside of conventional and evidence-based confines. In education and social disciplines, however, many untested approaches and ideas are accepted as status quo, and even become part of the dogma of the discipline.

Take, for example, the claims that one of the most effective ways to increase a child's achievement is to boost his or her self-esteem. As a result, a good portion of time that could be spent teaching skills is diverted to activities aimed at improving how children feel about themselves. However, there is little to no evidence to support such claims. To the contrary, as William Heward points out in his article, "Ten Faulty Notions That Hinder the Effectiveness of Special Education", there *is* evidence to support the notion that boosting a child's achievement is positively correlated to improvements in self-esteem (Heward, 2003). This is but one example of the staggering number of faulty concepts that are propagated throughout the social sciences (or, more accurately, social pseudosciences), and accepted as fact.

I believe this is a good area to bring up the ethical issue when delivering scientific, evidence-based intervention. In the article "The Right to Effective Behavioral Treatment," Van Houten et al. (1988) state that "an individual is entitled to effective and scientifically validated treatment" (p. 113). It is my firm belief that it is our responsibility as behavior analysts to be able to critique the literature to appraise the validity of the research being presented, to ensure that the individuals we serve receive the most effective treatment procedures.

With this being said, it raises the question: "How, then, should science be applied in the evaluation of treatment options?"

Seven Dimensions of Applied Behavior Analysis

Baer, Wolf, and Risley (1968) discuss **seven dimensions of applied behavior analysis** that serve as a guideline to clinicians to identify evidence-based interventions and research. These dimensions, applied, behavioral, analytic, technological, conceptually systematic, effective, and generality, are discussed below.

Applied

As it is stated in its name ***applied,*** in applied behavior analysis, indicates that the behavior of interest directly enhances and improves the individual's life. When selecting a behavior to change, it must have a direct impact on the individual's social and well-being.

For example, a behavior analyst has just started working with Tommy, a three-year-old boy with autism. During the Functional Behavior Assessment (FBA), the boy's parents identified several different behaviors that they want to be changed. These behaviors include stomping his feet, picking his nose, tantrums when he wants something, running out of the house and into the street, biting himself, and spinning in circles. Under the dimension of applied, the behavior analyst must select those behaviors that are of immediate need of change to improve the child's welfare and safety.

Looking at the list, what are the behaviors you would identify first to change? The correct answer would be biting himself, increasing functional communication, and running out of the house and into the street. These behaviors pose the greatest threat to Tommy's safety and have a direct impact on his well-being. Following intervention and a decrease in these behaviors, other behaviors identified by the parent can be targeted for change.

Behavioral

In applied behavior analysis, behaviors that are observable and measurable are the focus of intervention. The behavior selected for change must be able to be observed in the child's environment. It is not enough to be told a description of the behavior; the clinician must *directly observe* and precisely define the behavior. When defining the behavior, it must be in objective and measurable terms.

For example, if a child displays physical aggression, a possible definition might be, "hitting with an open hand, punching with a closed fist, kicking a person." These are specific descriptors that can be directly observed and measured. Another example would be if a teacher tells a behavior analyst that the student displays "anxiety," this is not sufficient. You cannot observe "anxiety." You can, however, observe behaviors that are associated with anxiety such as twiddling their thumbs, bouncing their knees up and down, pacing, or crying.

Second, as mentioned above, the behavior must be measurable. In other words, it must be so precisely defined that you are able to quantify its occurrence. Behavior analysts will use measurement systems such as frequency, duration, latency, etc., to measure and quantify the behavior of interest (discussed in detail in chapter 4). When measuring a behavior, it is essential that what the math teacher considers a tantrum and marks as such is the same thing that the gym teacher considers a tantrum and marks as well.

Analytic

According to Baer, Wolf, and Risley (1968), **analytic** implies that if a study has demonstrated control over a behavior; a functional relationship exists. By manipulating events in the environment, you can produce a consistent and reliable change in the behavior being studied. The dimension "analytic" enables us to demonstrate the effectiveness of our intervention as well as "provide the 'acid test proof' of functional and replicable relations between the interventions it recommends and socially significant outcomes" (Cooper, Heron, & Heward, 2020, p. 16).

Technological

The concept of **technological** suggests that all procedures and interventions are so precisely described that they can be applied and replicated in other studies with the same outcomes. When introducing an intervention to a teacher or a parent, the behavior analyst must thoroughly describe what to do when a target behavior occurs with such precision so that all involved professionals and caregivers are implementing the exact same procedure. In studies, when describing the intervention used, there must be ample detail so another professional can read what was implemented and can replicate it in a different setting with different participants.

Conceptually Systematic

In applied behavior analysis, the interventions used to treat behavior should always be tied back to the basic principles of behavior. Being **conceptually systematic** means that your interventions are consistent with principles that have been determined to be effective as defined in the research. Such principles of behavior can include stimulus control, extinction, reinforcement, and punishment. What we do to treat behavior does not involve a bag of tricks that we pull out of a hat to try to either increase or decrease a behavior. Our interventions are based on what the literature has shown to be effective over several decades of research.

Effective

When discussing whether a set of procedures are **effective**, there are two points to consider. First, to say an intervention is effective, it must improve the behavior of interest to a reasonable extent. This is fundamentally shown through the data collection and analysis. Does the data show a desirable change in the target behavior? Through replication, are the outcomes the same when implementing the same procedures?

We also need to consider if the procedures had the level of effectiveness to obtain a significant form of social validity. Do the skills we teach the child further his or her social abilities? If the answer to this question is yes, then the procedures we use are effective.

Generality

Generality of behavior change involves three main goals. The first is if the behavior lasts over time. During intervention, a desired change in the behavior will occur if the procedures are deemed effective. The question at hand is whether the desired change will continue once the interventions are withdrawn. Second, does the behavior occur in environments other than the one in which the intervention was employed? For example, if in a contrived setting, such as an outpatient clinic, will the desired behavior change occur in the child's home, school, and/or community settings? Last, does the change in behavior spread to other behaviors that are not directly treated by the intervention?

For example, Nick, who is taught the label of "dog" in presence of their pet Dachshund, can also apply this label when he goes to his grandparent's house when he sees their pet Golden Retriever. The goal of any program or intervention should be not only for the child to learn a skill when specifically taught it in one environment, but to use that skill across all environments, across all people, and across all exemplars they encounter.

These guidelines set out by Baer, Wolf, and Risley (1968) serve as useful and relevant markers for identifying and writing behavior analytic interventions. The behavior principles which our field was built on over 50 years ago remain the fundamental principles that we stand by today. It is our responsibility to continue basing our work on these dimensions and delivering interventions that produce a socially valid and meaningful change in behavior. As said by Cooper, Heron, & Heward (2020):

> "Science is a systematic approach to understanding natural phenomena, as evidenced by description, prediction, and control-that relies on determinism as its fundamental assumption, empiricism as its prime directive, experimentation as its basic strategy, replication as its necessary requirement for believability, parsimony as its conservative value, and philosophic doubt as its guiding conscience" (p.7).

Seven Dimensions of ABA

Applied –
Behaviors selected to teach are socially significant for the individual.

Behavioral –
The behavior of interest is observable and measurable.

Analytic –
The clinician can control the occurrence and nonoccurrence of the behavior.

Technological –
The steps of the intervention should be described in clear and concise terms for it to be replicated.

Conceptually Systematic –
Interventions are based on the basic principles of behavior.

Effective –
Data is collected on the intervention to evaluate changes in behavior and effectiveness of the intervention.

Generality –
The behavior occurs in environments other than where it was originally taught, lasts over time, and extends to other behaviors not directly treated by the intervention.

Additional Suggestions

First, be sure that the intervention in question has been shown to have an effect on the targeted problem. This is accomplished through controlled study and subsequent data collection and analysis. If proponents of any one approach cannot produce convincing data to demonstrate the effectiveness of the approach (anecdotes do not count; people can say anything did or did not happen), then it is not yet worth consideration.

Second, valid controlled investigations can, by nature, be replicated. If only one source has been able to produce favorable data, and others have failed to produce similar results, then the validitiy of the approach should be questioned. Applied behavior analytic approaches to teaching, learning, developmental disabilities, performance management, behavior problems and other social issues continue to gain validity in this way.

In addition to empirical strengths, it is important to turn to other objective parties to determine the merits of a questionable approach. This is accomplished through publication in peer-reviewed journals, where standards of research protocol are upheld and results are challenged. If the components of a particular approach have not appeared in peer-reviewed literature, its selection is risky.

Figure 3.1 presents a red flags checklist on detecting pseudoscience (McDonald & Reed, 2018). This information is intended to assist professionals to be more diligent when selecting interventions, to prevent readers from investing time and effort in intervention approaches that lack scientific merit, and to help readers be more conscientious in advising parents as to what intervention is most appropriate.

Red Flags of Pseudoscience

High "success" rates are claimed.

Rapid effects are promised.

The intervention is said to be effective for many symptoms or disorders.

The "theory" behind the intervention contradicts the objective knowledge (and sometimes common sense).

An overuse of ad hoc hypotheses designed to immunize claims from falsification.

The intervention is said to be easy to administer, requiring little training or expertise.

Other proven treatments are said to be unnecessary, inferior, or harmful.

Promotors of the intervention are working outside of their area of expertise.

Promoters benefit financially or otherwise from adoption of the treatment.

Testimonials, anecdotes, or personal accounts are offered in support of claims about the intervention's effectiveness, but little or no objective evidence is provided.

Obscurest language is used and prevents consumers from understanding.

Catchy, emotionally appealing slogans are used in marketing the treatment.

Belief and faith are said to be necessary for the intervention to "work."

Skepticism and critical evaluation are said to make the intervention's effects evaporate.

Promoters resist objective evaluation or scrutiny of the treatment by others.

Negative findings from scientific studies are ignored or dismissed.

There is a reversed burden of proof required.

There is evasion of peer review.

There is an absence of self-correction.

Critics and scientific investigators are often met with hostility, and are accused of persecuting the promoters, being "closed-minded," or having some ulterior motive for "debunking" the treatment.

Figure 3.1

I recommend McDonald & Reed's chapter in *Assessment in Autism Spectrum Disorder, 2nd Edition* (Goldstein & Ozonoff, 2018) as an excellent resource for information on pseudoscience. Other resources strongly encouraged to review on pseudoscience are Richard Foxx and James Mulick's book *Controversial Therapies for Autism and Intellectual Disabilities: Fad, Fashion, and Science in Professional Practice, 2nd Ed. (2015)* and Freeman's chapter *Alternative treatments for autism spectrum disorders: What is the science?* in *Sense and Nonsense in the Behavioral Treatment of Autism: It Has to be Said* (Freeman, 2008).

Last, I recommend you consult the National Standards Project (National Autism Center, 2015) which examines and quantifies the level of research supporting interventions that target the core deficits of children with autism through the age of 21. I believe these resources are particularly helpful for those who are interested in reviewing available intervention options for children with autism.

Finally, the following suggestions are offered:

* Be wary of approaches to intervention that employ testimonials as a prime source of information.
* Scrutinize provider-generated literature that is not referenced. The goal of such literature is often to advertise services or goods for sale, and it is possible that the provider has as much (or more) to gain from the sale as the consumer.
* There are published journals that are not devoted to experimental research. Pay close attention to the type of "research" that is being provided. Is it based upon surveys and other qualitative data (non-experimental), or is it based on the manipulation of events to test a hypothesis (experimental)?
* Look for peer-reviewed, experimental research. The process of peer review allows the research to be scrutinized to a high degree prior to publication.
* Understand both the usefulness and risks associated with the Internet. While it may be a terrific place to start your search for information on interventions, always proceed cautiously, and locate more solid evidence than what is posted on a web page.

In summary, maintain a healthy skepticism, and do so by remaining scientific and intelligent. This implies keeping an open mind, as scientific doubt requires one to change his or her stance when evidence requires it. As Carl Sagan (1995) claims:

> "Keeping an open mind is a virtue – but, as the space engineer James Oberg once said, not so open that your brains fall out" (p.177).

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