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PRECISION TEACHING: DISCOVERIES AND APPLICATIONS

Precision Teaching and Behavior Dynamics

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Abstract

Precision teaching (PT) comprises a sophisticated measurement and decision-making system aimed at helping its users foster superior outcomes for the clients or students they serve. The longevity of PT has led to many discoveries surrounding measurement, performance, learning, and behavior change. The contributions to knowledge derive from a range of studies. Some of the research uses single-case experimental designs, whereas the majority employs an approach called behavior dynamics. The use of behavior dynamics distinguishes PT from behavior analysis. Behavior dynamics does not seek to uncover functional relations. Nevertheless, behavior dynamics represents a sound approach to conduct research, generate reliable information, and engender knowledge.

Keywords Behavior dynamics · Precision teaching · Single-case experimental design · Standard celeration chart

Lindsley frequently gave credit to his mentor Skinner for his contributions to measurement and precision teaching (PT). In the opening paragraph of an article describing Skinner's influence, Lindsley wrote, "Precision teaching inherited 'rate of response' and 'cumulative response recording' from Skinner. This legacy is unique since precision teaching is the only instructional system derived from Skinner's work to use his monitoring method exclusively" (Lindsley, 1991, p. 253).

In *Skinner on Measurement*, Lindsley further described the elegance of his mentor's measurement system. As an example, cumulative response recording offered all first-generation behavior analysts a visual display that provided (a) real-time data visualizations, (b) individual behavior statistics, (c) standard slopes for all organisms, and (d) a doubling scale. The standard celeration chart (SCC) and PT not only descended from Skinner's measurement system but also became one of Lindsley's great contributions to the world.

PT does not require its users to adopt a specific curriculum or instructional method (White, 2005a). Instead, PT functions as an elegant measurement and decision-making system ripe for any behavior-change project. Both practitioners and researchers can benefit from PT in practice and experimental undertakings. Some of the many benefits follow the four-step PT process. First, pinpointing behavior or using a standard framework for precisely labeling target behaviors leads to clearly defined data targets and enhances communication of such data targets (Kubina & Yurich, 2012). A second benefit stems from an exclusive focus on dimensional measurement by applying universal and absolute metrics that quantify behavioral measures (White, 2005b). The use of dimensional quantities imparts standard, clear metrics that express the precise magnitude of change and help data analysis and communication.

A third benefit of PT is the use of a standard visual display (i.e., the SCC) that quantifies behavior change, maintains visual consistency from analyst to analyst, reduces interpretative errors, and facilitates pattern recognition (Calkin, 2005; Lindsley, 2005). The SCC offers a highly accurate representation of data and change patterns. Finally, the fourth benefit of PT involves a specific type of recursive problem solving or a model of successive, systematic attempts to change the course of behavior. The recursive model, a step in PT called "try again," produces a record of different interventions and there subsequent, quantified results documenting what intervention or class intervention holds promise (Kubina, 2019). For a more detailed description of PT and the SCC, several books present information about practice, research, and history (Haring, White, & Neely, 2019; Johnson & Street, 2013; Kubina & Yurich, 2012; Pennypacker, Gutierrez, & Lindsley, 2003).

Research Highlights
- The article will describe precision teaching as a system..
- The concept of behavior dynamics is explained.
- The article also contrasts behavior dynamics and single-case experimental design.

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One may ask what evidence base supports PT. The number of data-based projects including practitioner applications, academic studies to theses to dissertations, and peer-reviewed journal articles answers the previous question. In terms of practitioners, a two-volume collection of SCCs contained data from 12,000 different projects (Lindsley, Koenig, Nichol, Kanter, & Young, 1971). Later evidence of data came from an examination of SCCs from educational, clinical, and personal applications of PT. Over 1,200,000 SCCs appeared from the inception of PT to the year 2000 (Calkin, 2002).

Beyond practitioner data, the *Journal Precision Teaching and Celeration*, or JPTC (1980–2010), contained 433 articles consisting of experiments, discussion articles, technical notes, and chart shares (Kubina & Yurich, 2012). Almost all peer-reviewed experiments and chart shares contained an SCC and subsequent data analyses. And outside of JPTC, peer-reviewed articles appear in journals ranging from education (e.g., Peladeau, Forget, & Gagne, 2003) and behavior analysis (e.g., Cihon, 2007) to sports (e.g., Pocock, Foster, & McEwan, 2010) and medicine (McGrath et al., 2018). The massive amount of data and research suggests PT meets the threshold of being research based and evidence based (Kubina & Yurich, 2012).

Much of PT has provided results that differ from what most behavior analysts use in research. Specifically, PT has used an approach to research called behavior dynamics (Cooper, 2005). Behavior dynamics differs from single-case experimental designs (SCED) along several dimensions. Still, there are multiple ways to ask experimental questions. And the goal of all such experiments is knowledge creation.

Research and Knowledge

Experimenters in behavior analysis have used SCEDs as the main tool for conducting research (Cooper, Heron, & Heward, 2020; Matson, Turygin, Beighley, & Matson, 2012; Mayer, Sulzer-Azaroff, & Wallace, 2019). SCEDs have become an established method for determining functional relations between variables. According to the What Works Clearinghouse, SCED "can provide a strong basis for establishing causal inference, and these designs are widely used in applied and clinical disciplines in psychology and education, such as school psychology and the field of special education" (Kratochwill et al., 2010, p. 2). SCEDs help experimenters arrange and examine relationships occurring between and among variables (Kazdin, 2011). Figure 1 shows the symbolic representation of four common SCEDs that behavior-analytic experimenters can use to discover a functional relation between variables.

A number of excellent books describe how basic and applied experimenters use SCEDs to discover order in nature (e.g., Barlow et al., 2009; Johnston, Pennypacker, & Green, 2020; Kazdin, 2011; Kennedy, 2005; Ledford & Gast, 2018). The four experimental designs in Figure 1 work by establishing experimental control between the application of the independent variable, or intervention, and the dependent variable. Experimental control means an experimenter achieved a predictable change in behavior that is reliably produced by manipulating some part of the environment (Johnston et al., 2020). Experimental control occurs because the experimenter exercises a precise command of the implementation of the independent variable by presenting it, withdrawing it, or varying the value of it while holding all confounding and extraneous variables constant (Cooper et al., 2020).

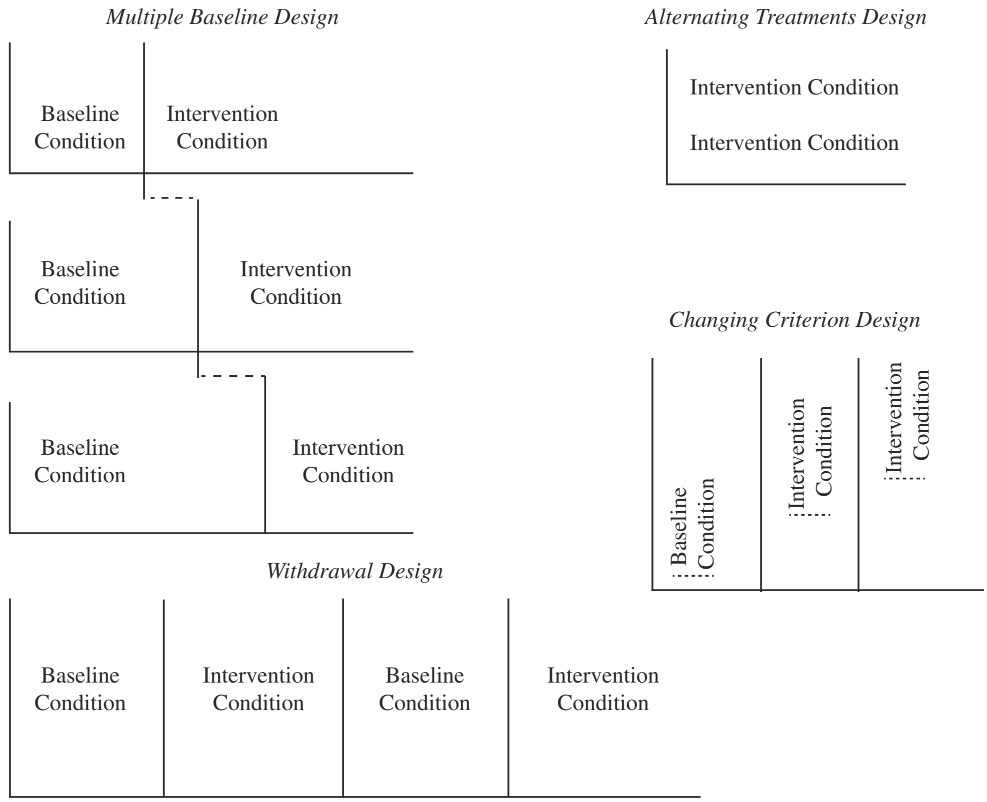
Conducting good science with SCEDs requires a high degree of planning, implementation fidelity, and resource availability and management. Within the context of PT, experiments using SCEDs, and the subsequent production of functional relations and experimental effects, have been performed (e.g., Datchuk, Kubina, & Mason, 2015; Kubina, Young, & Kilwein, 2004; Mrachko, Kostewicz, & Martin, 2017; Young, West, Howard, & Whitney, 1986). Yet the majority of people applying PT does not reside within a university setting where access to resources and other important components for conducting experiments exists. Teachers and learners within the home and private and public schools constitute the main body of people applying PT. Within home, private school, and public school settings, teachers and learners typically do not have the resources necessary for conducting controlled experiments that lead to the discovery of functional relations. Nevertheless,

> good science does not require experiments, it can be done with an intelligent use of observational evidence . . . there is more than one way to do science, depending on the nature of the questions and the methods typical of the field. (Pigliucci, 2010, p. 20)

Many scientific disciplines do not require experiments, but that does not mean these researchers cannot conduct good science that results in uncovering latent order in nature. Paleontologists, for instance, do not conduct experiments. Paleontology is the study of ancient life that examines the structure of organisms revealed by fossils found within rocks (Clark, 2004). Paleontologists cannot arrange conditions or make experimental manipulations to study extinct organisms. Instead, paleontologists can observe a particular type of fossil in specific rock strata. For example, trilobites no longer exist. Paleontologists, however, have learned a great deal about trilobites by examining their fossils in a geologic stratum existing within the Paleozoic era. Paleontologists have discovered different orders of trilobites, when they lived, where they lived, and how they lived, all without active experimentation.

Researchers within scientific disciplines such as paleontology and astronomy cannot conduct active experiments, but they can collect empirical data through observations and

Fig. 1 Symbolic representation of four common single-case experimental designs



produce and test hypotheses leading to reliable and valid knowledge about nature (cf. Cooper, 2005). Precision teachers who mainly operate in the fields of education and psychology do not face the same restrictions as paleontologists and astronomers; precision teachers can and do conduct experiments. Indeed, Lindsley often championed the use of an inductive approach over a deductive approach similar to other scientific disciplines that emphasize a "data-up" versus "theory-down" method for knowledge creation (Lindsley, 1991, 2010).

As a profession, teachers have a different charge when contrasted with those who conduct tightly controlled experiments that lead to functional relations—namely, producing learning outcomes for a student. Three principles define the role of teachers:

> Principle 1: The teacher makes a profound difference in how, what, when, and why students learn . . . Principle 2: Teaching involves creating as many opportunities as possible for successful learning . . . Principle 3: *effective* teaching enhances what the learner already knows and enables the learner to do things that could not be done before. (Darch & Kame'enui, 2004, pp. 13–15)

Teachers have an applied role similar to that of physicians, who aim to provide primary care for their patients. Family practice physicians typically do not conduct controlled research; they spend the majority of their time delivering a range of medical care services. Likewise, teachers focus their energies on creating successful learning outcomes for their students. Teachers and family practice physicians could conduct experiments; however, both professions concentrate on applied outcomes.

Behavior Dynamics Distinguishes PT

Teachers monitor learner behavior, apply good science to routine tasks and problems, and discover reliable information at a local level. When teachers apply PT, they can engage in a form of knowledge creation known as "behavior dynamics." Behavior dynamics refers to the study of behavior change. Skinner launched behavior analysis not with SCEDs but with behavior dynamics (Marr, 1992). The sheer number of replications of tightly run demonstrations of behavior change formed the foundation of the science of behavior.

Marr (1992) set out to first describe behavior dynamics as a way in which behavior-analytic research could prosper in light of Skinner's (1938) initial experiments. Marr drew an analogy to physics and explained the correspondence between mechanical and behavioral systems. Dynamical relations of behavior analysis extended to both molar and molecular features of behavior along with a host of interesting research possibilities. Opportunities to study dynamical relations in behavior analysis did not occur because the field "became obscured by aesthetics and seeming simplicity of steady-state performance" (Marr, 1992, p. 250).

Researchers in behavior analysis have spent the majority of their analytical effort with steady-state responding, as most prominently described by Sidman (1960). The framework in SCEDs used in behavior analysis relies on steady-state responding. On the other hand, PT is meant to examine variables that "induce transition states (i.e., acquisition, celeration) and other dynamic patterns of behavior change in each experimental condition and phase, but generally avoid demonstrations of steady states" (Cooper, 2005, p. 300).

Behavior dynamics designs employ change metrics such as celeration and bounce or variability, based on frequency, which examine variables between two or more conditions. A possible application of behavior dynamics in PT research is when the teacher implements an intervention or collects baseline data. Most precision teachers immediately implement an intervention because they do not delay teaching. PT seeks to apply interventions aimed at creating successful learning opportunities (baselines form a critical part of experimentation, even if the person has demonstrated learning).

Next, a decision rule or a teacher-established guideline (e.g., a specific period of time) triggers a condition change and a new intervention begins. For example, a decision rule may state that the intervention should change once the student has performed the target behavior at a given frequency level for 3 out of 4 days. The teacher then inspects the quantified measures of performance in the first condition (e.g., bounce or variability) and compares them to the quantified performance measures in the second condition (e.g., bounce or variability). The teacher could select from a variety of other analytical techniques that come to bear on the data evaluation between the two conditions, such as a frequency multiplier or celeration multiplier (Pennypacker et al., 2003).

The previous description may sound to some like an A-B design. A-B designs still seek to establish steady states even though they are the weakest SCED (Ledford & Gast, 2018). Behavior dynamics works by examining response variability similar to Skinner's early work (Cooper, 2005). For SCEDs that employ steady states, generality of findings occurs through direct and systematic replication. Therefore, examining changes across many students or research participants will show precisely how a class of interventions affects behavior change.

The research contrast between behavior analysis and PT demonstrates how Skinner's influence led to two different approaches to knowledge discovery. The success and tens of thousands of studies of SCEDs reveal important contributions to understanding behavior change in educational and psychological research (Ledford, Barton, Severini, & Zimmerman, 2019). Skinner's influence on PT came from Lindsley, who set forth a new approach that has led to millions of charts and an abundance of research articles spread across a number of journals. Experimenters in PT still have much to study and contribute to the understanding of behavior change, but the emphasis on behavior dynamics can drive PT research forward in the search for new knowledge.

Compliance with Ethical Standards

Conflict of Interest The author declares no conflict of interest.

References

Barlow, D. H., Nock, M. K., & Hersen, M. (2009). *Single case experimental designs: Strategies for studying behavior change* (3rd ed.). New York, NY: Pearson.

Calkin, A. B. (2002). Estimated number of standard celeration charts as of 2000. *Journal of Precision Teaching & Celeration, 18*, 33–34.

Calkin, A. B. (2005). Precision teaching: The standard celeration chart. *The Behavior Analyst Today, 6*(4), 207–215. https://doi.org/10.1037/h0100073.

Cihon, T. M. (2007). A review of training intraverbal repertoires: Can precision teaching help? *The Analysis of Verbal Behavior, 23*(1), 123–133. https://doi.org/10.1007/BF03393052.

Clark, J. O. E. (2004). *The essential dictionary of science*. New York: Barnes & Noble.

Cooper, J. O. (2005). Applied research: The separation of applied behavior analysis and precision teaching. In W. Heward, T. Heron, N. Need, S. Peterson, D. Sainato, G. Cartledge, R. Gardner, L. Peterson, S. Hersh, & J. Dardig (Eds.), *Focus on behavior analysis in education: Achievements, challenges, and opportunities* (pp. 295–303). Upper Saddle River, NJ: Pearson.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2020). *Applied behavior analysis* (3rd ed.). Hoboken, NJ: Pearson.

Darch, C. B., & Kame'enui, E. J. (2004). *Instructional classroom management: A proactive approach to behavior management* (2nd ed.). Upper Saddle River, NJ: Pearson.

Datchuk, S. M., Kubina, R. M., & Mason, L. H. (2015). Effects of sentence instruction and frequency building to a performance criterion on elementary-aged students with behavioral concerns and EBD. *Exceptionality, 23*, 34–53.

Haring, N. G., White, M. S., & Neely, M. D. (2019). *Precision teaching: A practical science of education*. In *Cornwall-on-Hudson*. NY: Sloan.

Johnson, K., & Street, E. M. (2013). *Response to intervention with precision teaching: Creating synergy in the classroom*. New York, NY: Guilford.

Johnston, J. M., Pennypacker, H. S., & Green, G. (2020). *Strategies and tactics of behavioral research* (4th ed.). New York, NY: Routledge.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings* (2nd ed.). New York, NY: Oxford University Press.

Kennedy, C. H. (2005). *Single-case designs for educational research*. Boston, MA: Allyn & Bacon.

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation*. Retrieved from the What Works Clearinghouse website: http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf

Kubina, R. M. (2019). *The precision teaching implementation manual*. Pittsburgh, PA: Greatness Achieved.

Kubina, R. M., Young, A. E., & Kilwein, M. (2004). Examining an effect of fluency: Application of oral word segmentation and letters sounds

for spelling. *Learning Disabilities: A Multidisciplinary Journal, 13*, 17–23.
Kubina, R. M., & Yurich, K. K. L. (2012). *The precision teaching book*. Lemont, PA: Greatness Achieved.
Ledford, J. R., Barton, E. E., Severini, K. E., & Zimmerman, K. N. (2019). A primer on single-case research designs: Contemporary use and analysis. *American Journal on Intellectual and Developmental Disabilities, 124*, 35–56.
Ledford, J. R., & Gast, D. L. (Eds.). (2018). *Single case research methodology: Applications in special education and behavioral sciences* (3rd ed.). New York, NY: Routledge.
Lindsley, O. R. (1991). Precision teaching's unique legacy from B. F. Skinner. *Journal of Behavioral Education, 1*, 253–266.
Lindsley, O. R. (2005). Standard celeration chart system. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy* (pp. 1546–1548). Thousand Oaks, CA: Sage. https://doi.org/10.4135/9781412950534.n3133.
Lindsley, O. R. (2010). *Skinner on measurement*. Kansas City, KS: Behavior Research Company.
Lindsley, O. R., Koenig, C. H., Nichol, J. B., Kanter, D. B., & Young, N. A. (1971). *Handbook of precise behavior facts*. Lawrence, KS: Precision Media.
Marr, M. J. (1992). Behavior dynamics: One perspective. *Journal of the Experimental Analysis of Behavior, 57*, 249–266. https://doi.org/10.1901/jeab.1992.57-249.
Matson, J. L., Turygin, N. C., Beighley, J., & Matson, M. L. (2012). Status of single-case research designs for evidence-based practice. *Research in Autism Spectrum Disorders, 6*(2), 931–938. https://doi.org/10.1016/j.rasd.2011.12.008.
Mayer, G. R., Sulzer-Azaroff, B., & Wallace, M. (2019). *Behavior analysis for lasting change* (4th ed.). Cornwall on Hudson, NY: Sloan.
McGrath, C., McCourt, C., Corry, A., Dounavi, K., Dillenburger, K., & Gormley, G. (2018). The use of "precision teaching" in enhancing medical students' dermatological diagnostic skills. *MedEdPublish, 7*(2), 1–17. https://doi.org/10.1037/bar0000082.
Mrachko, A. A., Kostewicz, D. E., & Martin, W. P. (2017). Increasing positive and decreasing negative teacher responses to student behavior through training and feedback. *Behavior Analysis: Research and Practice, 17*, 250–265.
Peladeau, N., Forget, J., & Gagne, F. (2003). Effect of paced and unpaced practice on skill application and retention: How much is enough? *American Educational Research Journal, 40*, 769–801. https://doi.org/10.3102/00028312040003769.
Pennypacker, H. S., Gutierrez, A., & Lindsley, O. R. (2003). *Handbook of the standard celeration chart*. Cambridge, MA: Cambridge Center for Behavioral Studies.
Pigliucci, M. (2010). *Nonsense on stilts: How to tell science from bunk*. Chicago, IL: The University of Chicago Press.
Pocock, T. L., Foster, T. M., & McEwan, J. S. (2010). Precision teaching and fluency: The effects of charting and goal-setting on skaters' performance. *Journal of Behavioral Health and Medicine, 1*(2), 93–118. https://doi.org/10.1037/h0100544.
Sidman, M. (1960). *Tactics of scientific research: Evaluating experimental data in psychology*. Boston, MA: Authors Cooperative.
Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. New York, NY: Appleton-Century-Crofts.
White, O. R. (2005a). Precision teaching. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy* (pp. 1433–1437). Thousand Oaks, CA: Sage. https://doi.org/10.4135/9781412950534.n3099.
White, O. R. (2005b). Behavioral dimensions. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy* (pp. 1183–1185). Thousand Oaks, CA: Sage. https://doi.org/10.4135/9781412950534.n3021.
Young, K. R., West, R. P., Howard, V. F., & Whitney, R. (1986). Acquisition, fluency training, generalization and maintenance of dressing skills of two developmentally disabled children. *Education and Treatment of Children, 9*, 16–29.