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Assessing Functional Relations: The Utility of the Standard Celeration Chart

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The discovery of functional relationships among variables is critical to the behavior scientist's goal of prediction and influence of behavior. Precision teachers' efforts are bolstered by their ability to illuminate functional relations between tool skills (e.g., letter sound fluency) and composite repertoires (e.g., oral reading fluency) using the Standard Celeration Chart (SCC). Ongoing assessment of composite repertoires in the context of tool skill interventions permits data-based decision making for optimal acquisition rates at the composite level. In this report, data obtained from learners enrolled in our handwriting curriculum illustrate the SCC's role in identifying and capitalizing on these functional relations.

Keywords: fluency, functional relations, precision teaching, prediction, progress monitoring

Science, as characterized by Hayes, Barlow, and Nelson-Gray (1999), is an enterprise that seeks to develop statements about relations among events. Scientific progress, therefore, is marked by increased sophistication of statements about the relations between events. Progress is achieved when scientists evaluate phenomena within a specified domain with precision, scope, and depth, facilitating prediction and influence, which is the goal of the behavior scientist. The ability to determine functional relations among variables and outcomes aids the behavior scientist in that quest.

The term functional relation is used in behavior science to describe the relationship between behavior and intervening variables, and these are of primary importance in clinical applications (Cooper, Heron, & Heward, 2007). If changes in the target behavior cannot be attributed to a programmed intervention, little can be said regarding functional relations. The goal of assessing functional relations between treatment and outcome is best achieved when the clinician or researcher is in close contact with the phenomenon of interest. The tool we select in the analytical process, therefore, provides the lens through which phenomena are examined. The standard celeration chart is an analytical tool with a standard visual display that permits rapid analysis and identification of functional relations (Kubina & Yurich, 2012). Thus, the precision afforded by the SCC aids the clinician in the formulation of statements about relations between events. A tool that expedites data-based decision making is to the advantage of the scientist–practitioner and, ultimately, the learner.

The following section will describe how the SCC can be used in the instructional design process to illuminate relations between component and composite repertoires. Moreover, we will demonstrate how the use of the SCC increased both the efficiency and efficacy of treatment protocols for two learners with handwriting deficits. Namely, we will illustrate how the SCC as an analytical tool facilitated goals of prediction and influence, and was instrumental in illuminating functional relationships between behaviors of interest.

Fit Learning, a precision teaching center in Reno, NV, noted a need for handwriting instruction for some learners. In response to that need, a curriculum scope and sequence, as well as an assessment, were developed. The fine-tuning of the sequence was inductive in nature; our quest

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was to develop and refine the curriculum through the analysis of functional relations between the individual components of a composite repertoire like handwriting. The curriculum was adapted from the Haughton Big Six handwriting targets (Haughton, 1999), and is composed of fine-motor targets, letter directionality concept instruction, and frequency-building practice on skills like tracing, basic strokes, forming letters, and copying words or sentences. Fine-motor training consists of timed opportunities for learners to engage the muscles of the hands, fingers, and forearms by squeezing items, picking items up, and isolated tapping or touching. Concept instruction on directionality for letter writing provides the learner with rules about how the letters should look, and how to form them appropriately, and includes practice opportunities for writing the letters. These elements were evaluated with respect to the frequency of correct letters written during a weekly alphabet-writing probe.

Method

Participants

Bart was a third grade learner enrolled for handwriting remediation. Paul was a second grade learner also enrolled for handwriting remediation. Both participants were enrolled in local public schools. Bart had a diagnosis of attention-deficit/hyperactivity disorder, and Paul had a diagnosis of hyperlexia.

Materials

An instructional program in handwriting was customized for both participants to address their individual needs following an intake assessment. Each learner's book contained charts, instructional scripts and descriptions, college-ruled lined paper, and pages of dashed letters for tracing. Learners used wooden number two pencils. In addition to these items for handwriting, each learner used a box of items for fine-motor training. These boxes included a bicycle horn, a foam football, a spray bottle, lacing cards, beans, cups, plastic tweezers, a rubber stress ball, hand grips (such as those rock climbers use to increase grip strength), blocks, and post-it notes.

Procedures

Each learner's chart (Figures 1 and 2) depicts a free/write alphabet task conducted once weekly. This task requires the learner to write the entire alphabet lowercase letters. Learners set goals for frequency and contact reinforcement when they meet those goals, but do not receive error correction. The learner was instructed to begin writing. When the learner formed the first letter of the alphabet, the timer was started. The total time required for the learner to write the alphabet was measured and the frequency of correct letters written per minute was calculated. The weekly assessment of letter writing served as a probe to evaluate the effects of component skill building. This probe was first done before beginning component skill training and weekly thereafter.

Following the first probe, each learner began the first phase of component skills: frequency building in fine-motor skills and basic strokes (writing tallies and drawing small circles on lined paper). Fine-motor training provided opportunities for the learner to engage and strengthen the muscles used for writing (e.g., honking a horn, squeezing a squirt bottle, and tapping isolated fingers); training in basic strokes entailed having the learner make tally marks on lined paper, as well as drawing small circles. Basic strokes training lasted approximately 25 hours of instruction. The next phase of instruction taught letter directionality. For Bart, directionality was taught in a fast-track approach. That is, Bart was taught directionality of letters with shared topography (e.g., letters with straight lines, letters with circles, letters with curved lines) and instruction alternated between groups of letters each session. Training included direct instruction about rules for the formation of letters followed by practice opportunities to write the letters. The decision to use a fast track approach is based on the learner's performance at intake (i.e., how far the learner's frequencies are from an established aim), and the learning picture that the team can draw from the SCC.

Paul's programming differed slightly. He still received directionality instruction, but his team trained each group of letters separately rather than with a fast-track approach, a strategy chosen because of the difference in Paul's perfor-

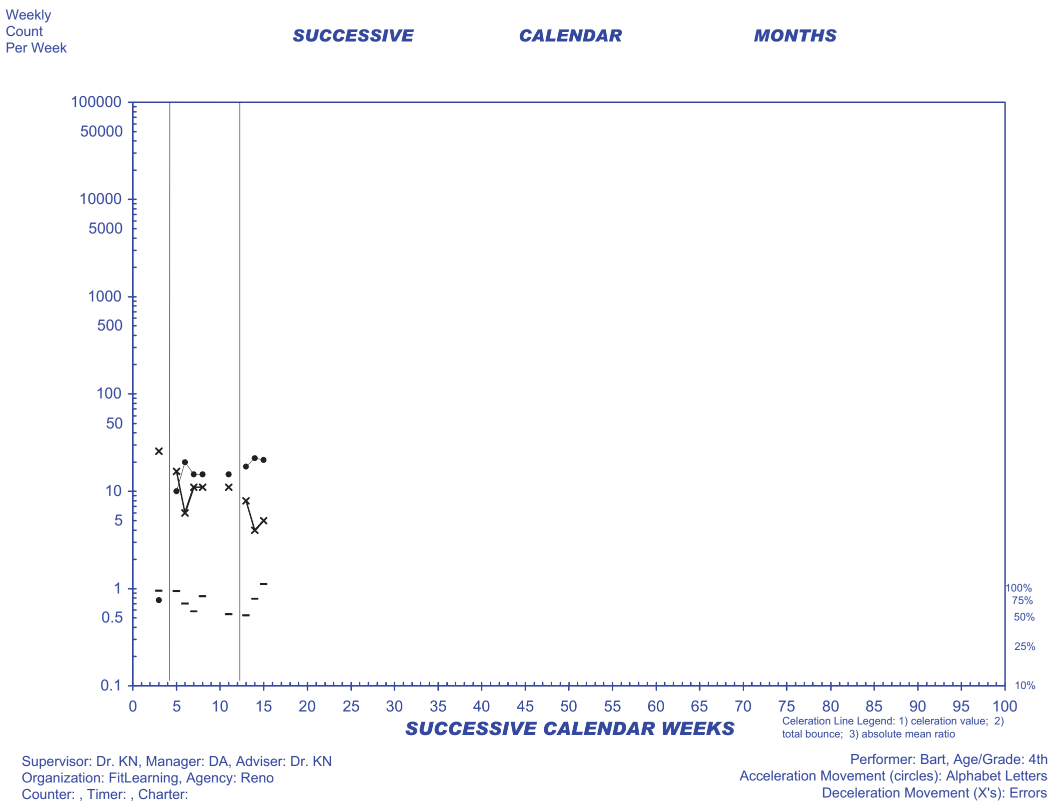

Figure 1. Bart's correct and incorrect letter writing. The black dots represent correct letters, and the ×s represent incorrectly written letters.

mance at intake and the established benchmarks for fluent performance.

Results

During the first assessment, Bart wrote at a frequency of zero correct responses per minute, and wrote incorrect letters at a frequency of 24.76 per minute. The first phase of component-skill building used fine-motor training and As component training progressed (for approximately six weeks), incorrectly written letters decreased to a frequency of 6.35 per minute, whereas correctly written letters increased to a frequency of 8.65 per minute.

After implementing directionality training, Bart's correctly written letters continued to increase, and his incorrectly written letters decreased. During the final assessment, Bart wrote correct letters at a rate of 23.33 per minute, and errors occurred at a rate of 5.56 per minute. Overall, an acceleration in correct letters was observed at a ×7.55, and a deceleration in errors was observed at a /3.77.

Initially, Paul wrote at a rate of 22.5 correct letters per minute, and a rate of 16.5 errors per minute. After beginning the fine-motor skills training sequence, correctly written letters increased to a rate of 23.4 per minute, 11.7 errors per minute. The final data point shows that Paul wrote correct letters at a rate of 29.28 per minute, and errors decreased to a rate of 2.44 per minute. Overall, Paul's data show an acceleration of ×1.32 in correct letters, and a deceleration of a /1.94 in errors.

Discussion

The charts for both learners depict, in time, the functional relation between training fine-motor targets and increasing the number of correctly formed letters and decreasing errors in writing

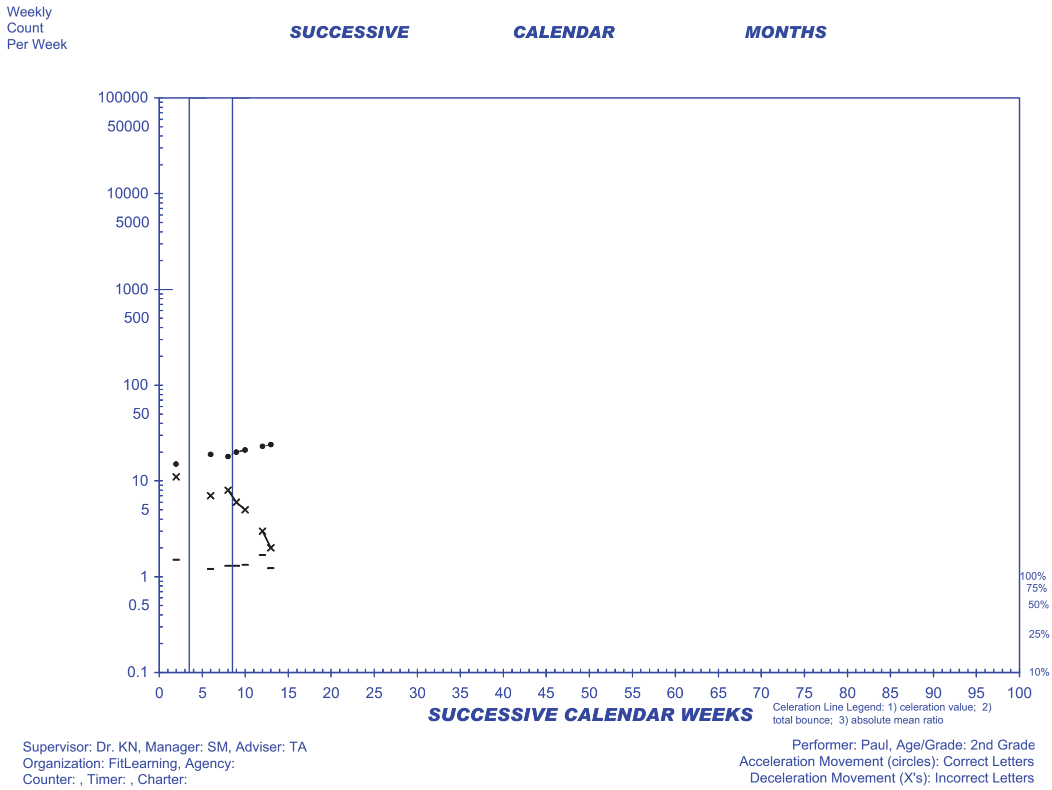

Figure 2. Paul's correct and incorrect letter writing. The black dots represent correct letters, and the ×s represent incorrectly written letters.

letters. Specifically, following each change in the intervention, correctly written letters increased in frequency and accuracy related to incorrectly written letters decreased in frequency (see Table 1). The addition of providing directionality rules, instruction, and practice opportunities increased correctly formed letters beyond the impact of only building fine-motor skills, and decreased errors in writing letters correctly. In addition, the treatment was delivered in a time-conscious manner (Bart received 25 hours of instruction, and Paul received 50 hours of instruction). Mastery of these skills will aid both learners in being successful in school and life.

The SCC's visual display and ease of data analysis can aid practitioners in determining functional relations between variables. The SCC allows us to detect the efficacy of the intervention easily, providing a lens for the discovery of functional relations between the vari-

Table 1
Summary of Rate per Minute Performance and Celeration

Participant	Rate per minute of correct letters: Initial timing	Rate per minute of correct letters: Last timing prior to directionality training	Rate per minute of correct letters: Last timing following directionality training	Overall acceleration of correct letters	Overall deceleration of incorrect letters
Bart	.0	8.65	23.31	×7.55	/3.77
Paul	22.5	23.4	29.28	×1.32	/1.94

ables of interest (in this case, component behaviors that serve as a prerequisite to the larger composite repertoire that makes up handwriting). The previous examples illustrate how the SCC can foster the identification of functional relations between component and composite repertoires. What's more, training fine-motor skills is an essential component of correct handwriting. The examples illustrate the ease with which data are analyzed. The use of the SCC is a critical component of the inductive approach to developing and refining this curriculum area. As behavior analysts, we strive to treat behavior in a methodical, orderly way, and the SCC aids us in doing so. For Bart and Paul, building fine-motor skills and training directionality concepts yielded a clinically significant impact on alphabet writing. Bart and Paul's data illuminate how functional relations among elements of the handwriting curriculum and composite outcomes can be observed and acted upon in real time in a clinical setting by using the SCC to display and analyze our phenomenon of interest.

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