Behavioral Development Bulletin
2015, Vol. 20, No. 2, 150–157

1942-0722/15/$12.00 http://dx.doi.org/10.1037/h0101307

Discovery Through the Lens of the Standard Celeration Chart: Informing and Facilitating Inductive Intervention Strategies

Staheli Meyer, Tiffany Aninao, Kendra Newsome, and Donny Newsome
Fit Learning, Reno, Nevada

Key to the success of Precision Teachers is an understanding that accuracy of performance is necessary, but insufficient for skill mastery. Dimensions of behavior occurring in time, such as rate, latency, or duration, must also be included in determinations of competence. By employing the Standard Celeration Chart, which allows assessment of all the above features of responding, Precision Teachers can detect and address barriers to mastery that go beyond issues of accuracy. Included here are examples of successful behavioral interventions whose discovery is attributed to the use of this sensitive measurement tool. The first intervention presented shows the effects of an error defusion intervention on passage reading. The second intervention demonstrates the impact of a discrimination priming on a picture-naming task. In the before mentioned interventions, the Standard Celeration Chart was paramount in the discovery of key performance variables.

Keywords: defusion, discrimination, intervention, momentum

In the applied domain, the ambition of the practitioner is the design of effective treatments to produce meaningful outcomes for the individuals served. The principles of learning inform our treatments as scientists, but the practitioner is concerned with more than an understanding of principles; the practitioner is concerned with clinical significance and extent of benefit (Azrin, 1977).

As an applied science, Precision Teaching has yielded scores of discoveries about teaching and learning (Binder, 1996; Lindsley, 1992; Haughton, 1972). The use of this sensitive, standardized measurement tool has set the occasion for these discoveries and is an ideal tool for the practitioner. The standard celeration chart (SCC) is a tool that optimizes the discovery of key performance variables in the applied arena; it allows assessments of frequency, latency, and duration in real calendar time, facilitating the detection of barriers to acquisition and mastery, important matters for the practitioner. With its use, trends are quantifiable, and patterns are easily detected across multiple behaviors of interest. Thus, the SCC functions as a powerful measurement tool and means to evaluate of the efficacy of clinical interventions (Binder, 1996; Kubina & Yurich, 2012).

The purpose of this article is to illustrate how the SCC, when used to measure behavior in an applied setting, led to the design of interventions that produced meaningful outcomes for the individuals served. In particular, the use of frequency as the primary datum and the depiction of real calendar time along the horizontal axis allowed for important discoveries with respect to our phenomenon of interest: the acquisition of academic behaviors.

Because the SCC uses frequency as its primary datum, performance can be evaluated with respect to the frequency of correct responses, as well as the frequency of incorrect responses, a benefit not afforded by percent correct measures. The first intervention described, error defusion, exemplifies how the SCC allowed for the detection of long interresponse times during reading activities and the determination of clinical benefits following intervention. The second intervention demonstrates how the SCC facilitated comparisons between academic programs,

This article was published Online First September 21, 2015.

Staheli Meyer, Tiffany Aninao, Kendra Newsome, and Donny Newsome, Fit Learning, Reno, Nevada.

Correspondence concerning this article should be addressed to Staheli Meyer, Fit Learning, 9408 Double R Boulevard, Suite B, Reno, NV 89521. E-mail: staheli@meyer.net

which revealed differences in a learner's acquisition patterns and led to an inductive approach to ameliorating those differences.

Error Defusion

Defusion, a technique borrowed from Acceptance and Commitment Therapy, is understood to alter the aversive function of verbal stimuli, including private events. Similar to interventions commonly applied in the treatment of anxiety disorders, defusion protocols involve systematic, repeated exposure to stimuli that have historically evoked avoidance behaviors. The principal of habituation and related techniques such as 'flooding' are instructive conceptual parallels in the traditional behavior analytic literature. The error-defusion protocol described herein represents an attempt to alter the aversive functions of textual stimuli likely to occasion errors and/or general response suppression, thereby reducing the need for prompting and resulting in increasing acquisition frequencies.

Method

Mike was a 12-year-old boy diagnosed with Selective Mutism. Mike was referred to Fit Learning for reading remediation. His reading skills at intake were assessed to be six grade levels behind his age-matched peers. Based on the intake assessment, a reading program was designed to improve Mike's reading abilities. Sessions were conducted five days per week for two hours per day.

During reading sessions, a number of reading components were targeted and plotted on the SCC. These component skills were selected based on the intake assessment and included skills such as letter sound identification, decoding and reading words that follow specific phonetic patterns, and passage reading. Mike's progress toward grade level reading was monitored weekly using Aimsweb™ reading passages, a standardized curriculum-based measurement tool (CBM).

Aimsweb™ reading CBMs were administered weekly. Mike was presented with a novel CBM passage each week and asked to read aloud for one minute. The number of correctly read words and errors were scored during this 1-min period. If Mike failed to respond to a word within three seconds, the instructor verbally prompted Mike with the full word. This was counted as an error. CBM data were then plotted on the SCC.

Through analysis of CBM data, it was discovered that instances of nonresponding reliably occurred in the presence of unfamiliar words. As a result, Mike's overall frequencies of correct responding were low and his frequencies of errors due to nonresponding were high. This pattern of behavior was observed across the majority of his other reading programs as well. Following failed strategies such as prompting Mike to apply mastered decoding skills and/or ask for help. The practitioner identified that in stimulus conditions where incorrect responding was probable, Mike engaged in behavior tantamount to learned helplessness (Abramson et al., 1978). Therefore, an error defusion task was implemented. The rationale for this task was to reduce, or 'defuse,' the aversive functions of stimuli likely to occasion errors attributable to nonresponding (Törneke, 2010).

The Error Defusion program was run at the beginning of each day in the context of Mike's reading sessions. Multiple levels or "slices" of error defusion were sequentially introduced as mastery criteria on the slice in acquisition were met, and each iteration involved a closer approximation to the targeted response during CBM passage reading. The levels are described in order of presentation, and four slices were introduced. During the first slice of error defusion, Mike was presented with a sheet of six colors. The colors randomly repeated throughout the sheet, and each row contained 10 exemplars. Mike was given the instruction to engage in any response similar in topography to the correct response (i.e., another color), but only 'incorrect' responses were reinforced. For example, if the color red was presented, reinforcement was available for naming any color on the sheet except red.

For slice 2, Mike was presented with a sheet containing five sight words. The organization of this stimulus sheet followed the same patterns as the sheet used for colors, and the instructions were the same. For example, if the word "this" was presented, reinforcement was available for the spoken response of any other word on the sheet except "this."

The next slice in the error defusion sequence utilized multisyllabic words above Mike's current reading and decoding level. In this iteration, Mike was instructed to sound out the presented word. For scoring purposes and reinforcement, the accuracy of Mike's response was irrelevant. Mike's goal was to respond by attempting to decode the word (e.g., sound out). For example, if the word presented was 'decide' Mike could have responded by saying "d" – "e" –"k" – "d" – "dekd". Attempts to decode were counted as correct responses regardless of whether the sounds Mike produced corresponded to the sounds of the word.

The final slice in the error defusion sequence consisted of sentences with one or two nonsense words embedded in each sentence. A new criterion was stated for this level of training. Correct responses required that Mike meet an interresponse time goal. Thus, reinforcement was contingent on Mike's response to the embedded nonsense word, which had to occur within two seconds of him reading the word that preceded the nonsense word. If the interresponse criterion was met, a correct response was counted.

In all phases of error defusion, frequency goals were stated for each practice opportunity, and points were delivered if the frequency goal was obtained.

Results

Figure 1 shows the effects of the error defusion intervention on Mike's reading CBM. Dots represent individual frequencies of correct responses, whereas '×' represents the frequency of errors scored for nonresponding or reading a word incorrectly. Trends of correct or incorrect responding are visual denoted by a black line. This trend line is quantified with the celeration calculation, which yielded numbers found in Table 1. An increasing frequency is quantified as acceleration (×), whereas a decreasing frequency is quantified as deceleration (÷). Bounce is a measure of variability in responding and are denoted as green lines, and yielded numbers found in Table 1.

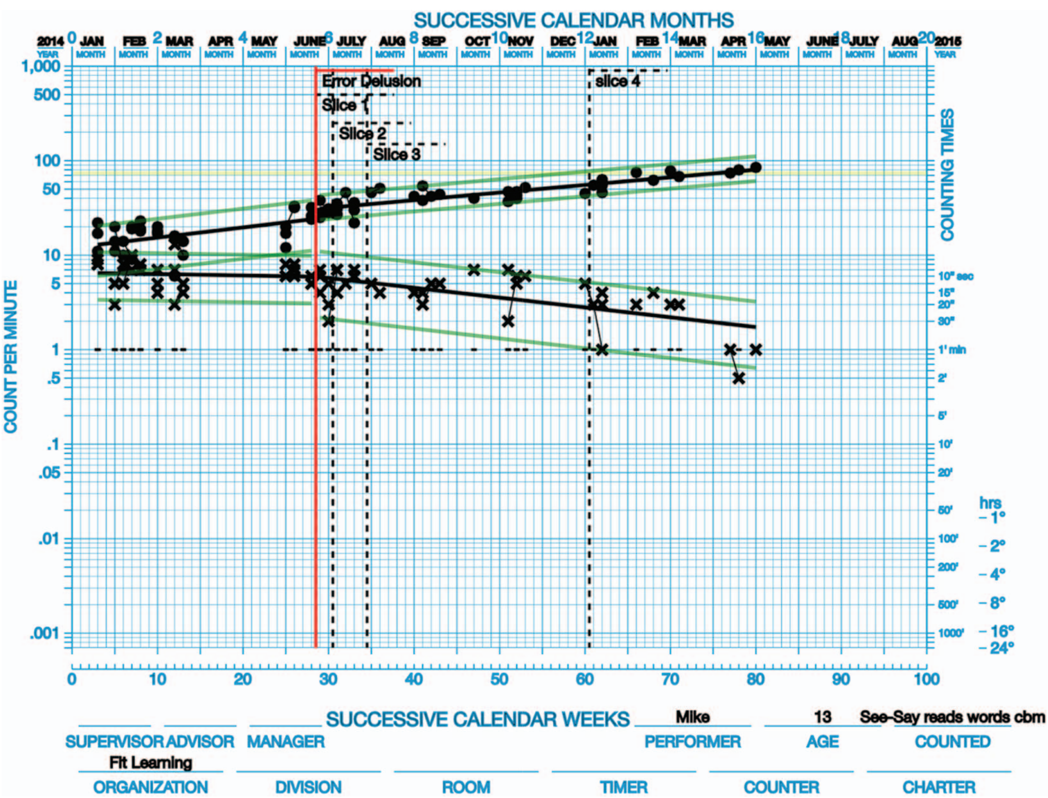

Figure 1. Frequency of correct and incorrect words read on a reading CBM.

Table 1
Performance Measures Before and After Error Defusion Intervention

Measure	Before error defusion	After error defusion
Acceleration of correct responses	× 1.13	× 1.11
Deceleration of incorrect responses	÷ 1.02	÷ 1.13
Bounce of correct responses	× 3.4	× 1.8

The acceleration of correct responses before error defusion intervention was × 1.13, after intervention celeration was × 1.11. The deceleration of incorrect responses before intervention was ÷ 1.02, after the intervention deceleration was ÷ 1.13. Variability, or bounce, in correct responding before the intervention was × 3.4; after the intervention bounce decreased to × 1.8 (see Table 1).

Before the error defusion programing, correct and incorrect responses were largely undifferentiated. After the implementation of slice 1, an immediate differentiation between these responses is observed; correct responses increased in frequency and incorrect responses decreased. This pattern continued through the implementation of slice 2 and subsequent slices. After the implementation of slice 3, correct responding continued to celerate and Mike's reading speed increase from 28 words per minute after the initial implementation of error defusion slice 1, to a frequency to 55 words per minute at the end of training in slice 3. Following the implementation of slice 4 of the defusion programing, the steepest rate of deceleration of errors due to nonresponding was observed, ÷ 1.39. During the months the error defusion intervention was in place the level of the Aimsweb™ reading passages was increased from kindergarten grade level passages to 2nd grade level passages. Following the implementation of the error defusion programing, Mike's reading frequencies increased by 57 words per minute in 52 weeks. The terminal frequency measured on the last observation period was 85 words per minute on a 2nd grade reading passage.

Antecedent Priming

Behavioral momentum, a "metaphor used to describe a rate of responding and its resistance to change following a [change] in reinforcement conditions" (Rosqvist & Hersen, 2005, p. 691), has been used to illustrate effects of an antecedent intervention of presenting high-probability requests in a sequence (Cooper, Heron, & Heward, 2007). The second intervention in this report demonstrates how the SCC enabled the discovery of different acquisition rates between similar academic programs, which informed a momentum-based intervention. Because the SCC is standardized by time, all charts for a given learner's programming are date-synchronized allowing for comparisons between training programs occurring in real time. In this case, a difference in acquisition rates was discovered between naming tasks—picture names and category identification. These programs shared many features—the stimulus materials were the same (flashcards), the practice intervals were the same (15-s), and the frequency aim was identical (50–60 responses per minute). Thus, in an inductive inquiry, other variables impacting acquisition on the picture-naming tasks were considered. Further analysis revealed that at least two aspects differed: the number of discriminations required and the history of reinforcement with respect to each program. The category identification program required only five differentiated responses, whereas the picture naming task required 18 differentiated responses. Moreover, rates of reinforcement were higher on the category identification task than for the picture-naming task as a result of frequency goals being met more frequently.

Method

An antecedent intervention was selected to evaluate whether the "momentum" of high rate responding during a flash card priming task would be effective for increasing frequencies on the picture-naming task. Sally was a 6-year-old girl diagnosed with Downs Syndrome. Sally was referred to Fit Learning for language enrichment and comprehension training. Based on the intake assessment, a relational language program was designed to improve Sally's language and comprehension abilities. During each session, 8 to 10 different skills were targeted for acquisition, including picture and category identification. Sally's session were conducted five days a week, for one hour each day.

A priming task was implemented before the picture-naming program wherein only two discriminations were present in the stimulus array to see whether the frequency of responding occasioned during the priming task would facilitate an increased frequency of responding during the picture-naming program. A flashcard deck was constructed that contained two items: cups and airplanes. Sally had a history of reinforcement for correct naming of these objects. The deck included multiple exemplars of cups and airplanes. Sally was given a frequency goal for responses in a 15-s timing. Reinforcement was provided contingent on meeting the frequency goal. The priming task was implemented once a day before Sally's regular picture naming program.

Results

Figure 2 shows Sally's celeration on a category identification task where only five discriminations were required. Figure 3 shows Sally's celeration on a picture-naming task where 18 discriminations were required. Differences in acquisition rates are observed between category identification tasks (× 1.81), and picture-naming tasks (× 1.08).

Figure 4 shows the effects of a discrimination priming on frequency and stability of responding on the aforementioned picture-naming task. Dots represent frequencies of correct responses and the '×' represents frequencies of error responses. An '×' under the record floor indicates no error was recorded. Again, black lines denote

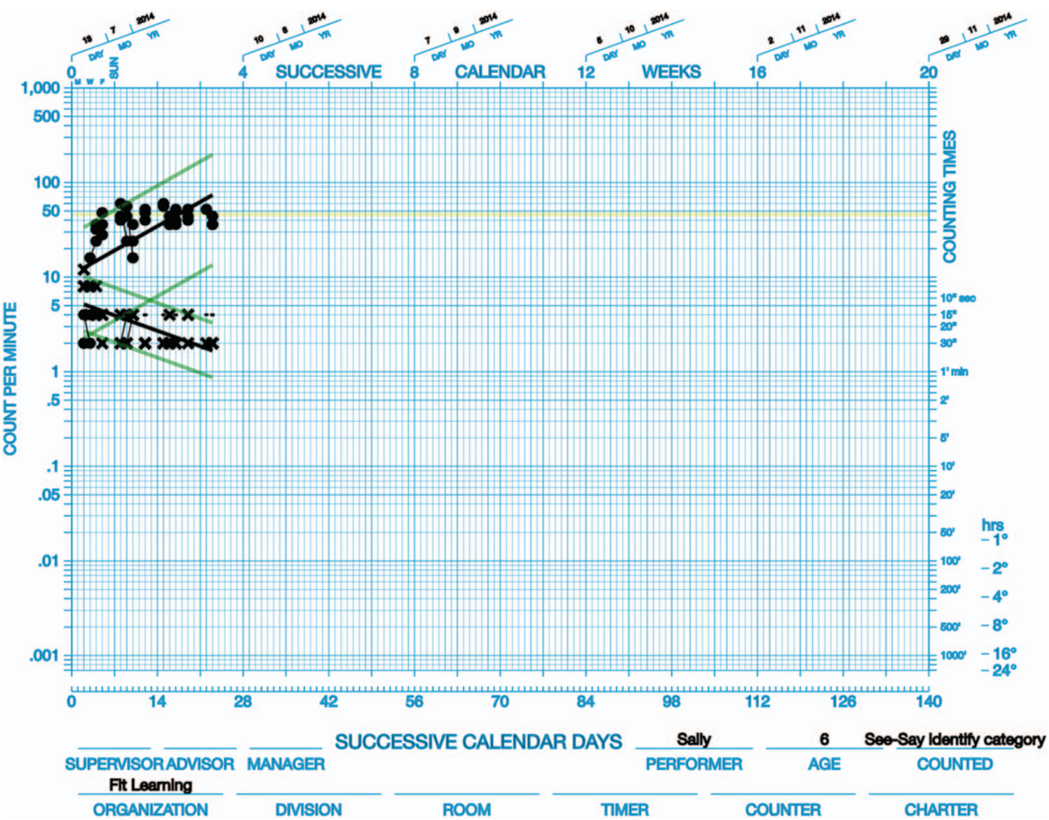

Figure 2. Frequency of correct and incorrect on category identification task.

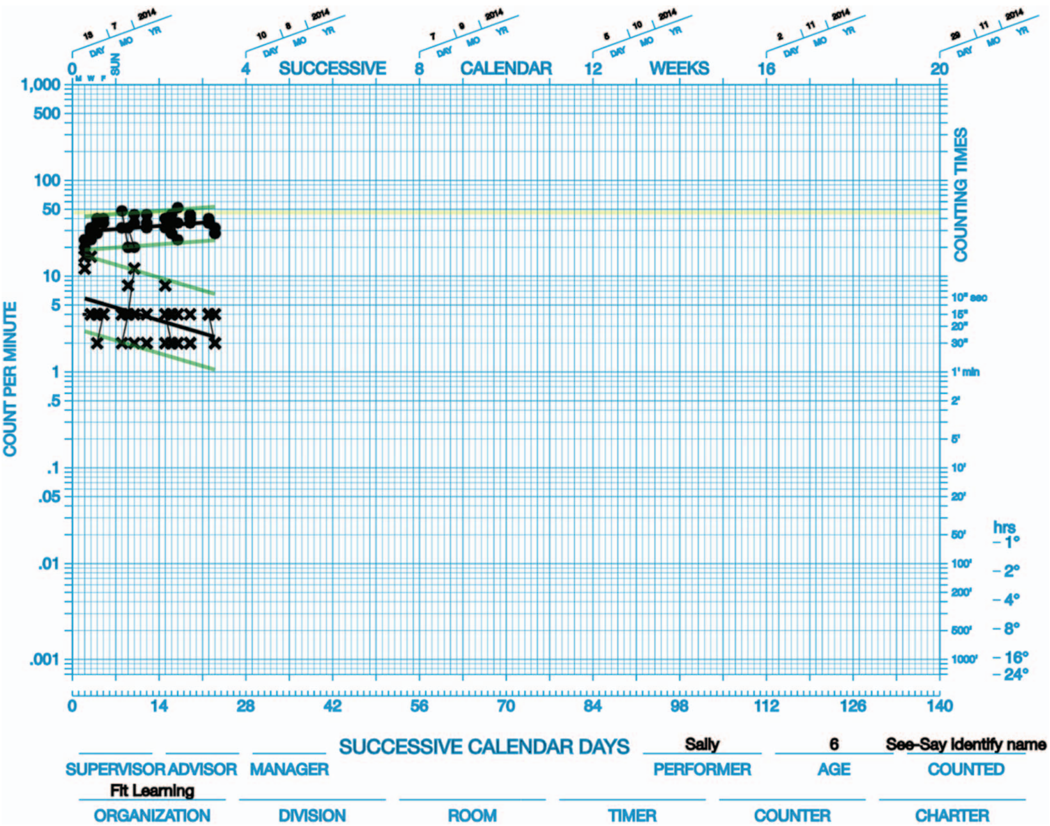

Figure 3. Frequency of correct and incorrect on picture-naming task.

celerations, and green lines show bounce. The acceleration of correct responses before the intervention was 1.08. After the intervention the celeration was 1.24. Before the intervention the bounce was × 2.20. After the intervention bounce was × 1.40 (see Table 2).

Discussion

The SCC offers behavior scientists a system for measuring dimensions of behavior occurring in real time on a standard display, therefore facilitating visual inspection and detection of clinical benefit. This allows the impact of interventions to be easily measured across many related stimulus and response classes. Both of the case studies presented here demonstrate the utility of the SCC in detecting suboptimal performance patterns, informing context-specific intervention strategies, and evaluating the localized effectiveness of those interventions.

In both examples discussed, the SCC facilitated the discovery of clinically significant and meaningful outcomes that might have otherwise been masked by the measurement system. This error defusion programing was informed by conceptual principles of learning, but evaluated by the practitioner for the extent of benefit for the individual being served. Patterns in Mike's acquisition data showed long interresponse times to particular stimuli. Without frequency as a unit of measurement, this dimension of responding would have gone undetected. A procedure to alter the aversive function of textual stimuli likely to occasion general response suppression was implemented. This procedure resulted in increased acquisition rates, and a decrease in errors attributable to nonresponding. In this instance, barriers to mastery were detected, and an inductive intervention was implemented.

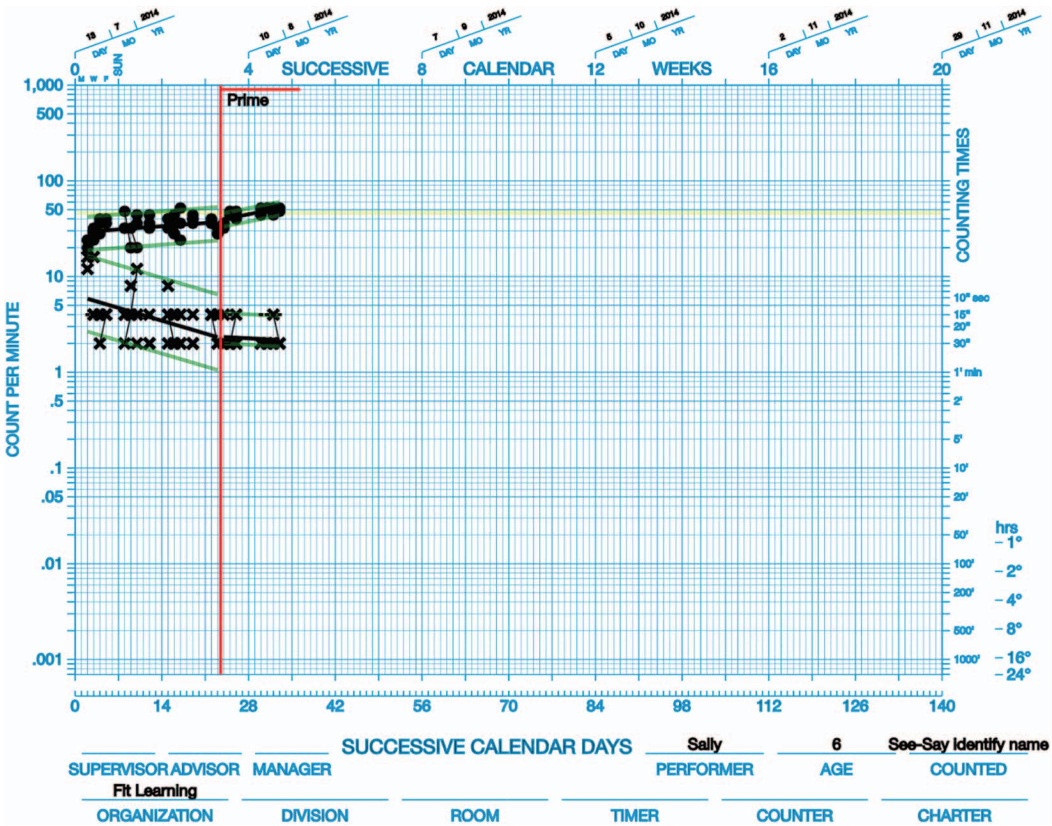

Figure 4. Frequency of correct and incorrect on picture-naming task.

In Sally's case, the standardized features of the SCC and the plotting of frequency in real time led to the discovery that similar tasks yielded different acquisition patterns. This discovery guided the implementation of an antecedent priming task, which increased frequency of responding and stability on the targets in acquisition. Practitioners, having identified the differential rates of acquisition, were able to isolate potential variables impacting acquisition rates (e.g., reinforcement history), which informed the use of specific tactics (e.g., behavioral momentum) for altering the acquisition pattern.

Table 2
Performance Measures Before and After Prime

Measure	Before prime	After prime
Celeration of correct responses	× 1.08	× 1.24
Bounce of correct responses	× 2.20	× 1.40

In the applied domain, it is the goal of the practitioner to design effective treatments that produce meaningful outcomes. Practitioners are only as effective as the tools they use to contact their subject matter. When the SCC is utilized, trends are quantifiable, and patterns are readily detected. Frequency, latency, and duration are all dimensions of behavior. Measurements of these dimensions on a standardized display that yields quantifiable changes in behavior facilitate the detection of barriers to acquisition and mastery, both of which are important considerations for the practitioner.

References

Abramson, L. Y., Seligman, M. E., & Teasdale, J. D. (1978). Learned helplessness in humans: Critique and reformulation. *Journal of Abnormal Psychol-*

ogy, 87, 49–74. http://dx.doi.org/10.1037/0021-843X.87.1.49

Azrin, N. (1977). A strategy for applied research: Learning based but outcome oriented. *American Psychologist, 32,* 140–149. http://dx.doi.org/10.1037/0003-066X.32.2.140

Binder, C. (1996). Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst, 19,* 163–197.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis*. Upper Saddle River, NJ: Pearson Education, Inc.

Haughton, E. (1972). Aims—Growing and sharing. In J. B. Jordan & L. S. Robbins (Eds.), *Let's try doing something else kind of thing: Behavioral principles and the exceptional child* (pp. 20–39). A report from the Invisible College Conference on Application of Behavioral Principles in Exceptional Child Education, March, 1971. Arlington, VA: The Council for Exceptional Children.

Kubina, R. M., & Yurich, K. K. L. (2012). *The precision teaching book*. Lemont. PA: Greatness Achieved Publishing Company.

Lindsley, O. R. (1992). Precision teaching: Discoveries and effects. *Journal of Applied Behavior Analysis, 25,* 51–57. http://dx.doi.org/10.1901/jaba.1992.25-51

Rosqvist, J., & Hersen, M. (2005). Behavioral momentum. In M. Hersen (Ed.), *Encyclopedia of behavior modification and cognitive behavior therapy*. Thousand Oaks, CA: Sage.

Törneke, N. (2010). *Learning RFT: An introduction to relational frame theory and its clinical applications*. Oakland, CA: New Harbinger Publications, Inc.

Received December 19, 2014
Revision received May 17, 2015
Accepted May 18, 2015 ■