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HELPING ONE PERSON AT A TIME: PRECISION TEACHING AND TRAUMATIC BRAIN INJURY REHABILITATION

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The managed care movement has had a considerable effect in health care. Professionals and agencies in rehabilitation of traumatic brain injury (TBI) now have increased pressure to produce significant clinical outcomes in an abbreviated time frame. As the interest for effective treatment practices grows, a new resource, precision teaching, offers intriguing possibilities for practitioners and researchers. This article presents a case study illustrating precision teaching with a person with TBI and provides suggestions for incorporating precision teaching into rehabilitative settings. Copyright © 2000 John Wiley & Sons, Ltd.

Medical technology increases at a rapid pace. With the advancements made in fields such as critical care, neurosurgery, and emergency medicine it seems almost certain that substantially more people will survive traumatic brain injuries than before. This trend places special emphasis on rehabilitation and makes it an important topic for the future of health care.

Many new challenges face the professionals and agencies providing brain injury rehabilitation including concerns surrounding clinical outcomes. Haffey and Lewis (1989) propose two central questions in their 'state of the art review'. The first asks whether rehabilitation produces changes in the condition of the person with TBI. The second, more pragmatic question: does rehabilitation improve or positively impact the person's life in a significant manner? The clinical outcomes attained by the helping professions involved in the rehabilitation process ultimately answer these questions.

Increasingly, more people have examined clinical outcomes. This close scrutiny has occurred because interest in clinical outcomes accelerated since funding sources and accrediting agencies began requiring service providers to deliver the most effective outcomes for the least amount of money (Ling & Evans, 1997). The

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trend towards identifying important outcomes focuses public and professional attention on the process and product of clinical applications.

One very influential source on rehabilitation of TBI comes from the managed care movement. Managed care seeks to control costs and monitor and improve the quality of health care; however its focus bears on reducing costs (Grayson, 1993). In terms of accountability for cost and time effective practices, managed care's effect has had considerable impact.

The pressure of managed care and other reform minded sources occasions re-evaluation of clinical practices. The growing search for effective practices has promoted the identification of difficulties in the applied research database. For instance, Keith (1995) suggests not making causal inferences from many rehabilitation outcome studies because researchers did not control for variables such as spontaneous recovery. Other critiques include concerns with experimental methods such as ill defined outcome measures, omissions of critical data (e.g., pre-injury characteristics, localization of brain injury), and problems with data collection and analysis.

Rehabilitation of persons with TBI apparently does not have access to a database for making informed decisions. The core study of most rehabilitation research constrains that database. In other words, the primary concern of applied treatment rests with the improvement of a client's welfare, and rehabilitation does not always make the rigors of science a first concern. As Hall and Cope (1995) note, rehabilitation of TBI has proven difficult to research scientifically because the primary means of evaluating most treatments have focused on interpersonal, not physiologic, variables. Except for personal experience, how can consumers and professionals determine which methods cost the least and produce the most effective clinical outcomes?

One answer involves ameliorating the scientific quality of demonstrating treatment outcomes. High, Boake, and Lehmkuhl (1995) outline some recommendations that concern improving the current system of study by ameliorating current methods. Another possibility, not mentioned by High *et al.*, involves using an ancillary approach that could supplement, or in some case, serve as the primary means for data collection. This approach entails augmenting current clinical trials with an established data collection system, namely, precision teaching.

WHAT IS PRECISION TEACHING?

Ogden Lindsley founded precision teaching, which consists of a set of precise and systematic procedures for practicing, measuring, monitoring, and evaluating academic or social performance (Binder & Watkins, 1990; Lindsley, 1990b; Maloney, 1998; West & Young, 1992; West, Young, & Spooner, 1990; White, 1986). Precision teaching, originally developed for use by classroom teachers, can improve any academic program (Lindsley, 1992). The *Journal of Precision Teaching and Celeration* (*JPT & C*) has seen a long and rich history of reporting teachers' remarkable academic success with a variety of learners.

For instance, when used with Montessori, an educational program, results indicated a major improvement (Lindsley, 1992). Also, the marriage of precision teaching and direct instruction, an educational curriculum, has resulted in incredible student performances (Desjardins & Slocum, 1993; Johnson & Layng, 1992; Maloney, 1998; Maloney, Desjardins, & Broad, 1990; Morrell, Morrell, & Kubina, 1995). Students routinely display multiple years of improvement in one, and even sometimes less than one, academic year. The refined student behavior occurs as the result of synergistically combining a specific curriculum, direct instruction, and a measurement system producing feedback allowing facilitation of informed decisions, precision teaching.

Four main guidelines direct precision teachers. First, precision teachers focus on directly observable behavior. For instance, the number of smiles in an hour or positive statements about self in a day said by a child allows others to directly observe a behavior. A positive 'self concept' provides a nonexample of focusing on directly observable behavior. In other words, constructs or other hypothetically defined entities do not lend themselves to direct observation by another person.

Second, precision teachers use the frequency, synonymous with 'rate', of response as the measure for all accomplishments. A frequency signifies a count of a behavior that occurs within a given observation period or time (Johnston & Penneypacker, 1993). Precision teachers usually report a frequency as count per minute, count per day, count per week, or count per month. A student orally reading 135 words correctly in a minute provides an example of a frequency measure. Reading 80% of a passage depicts a nonexample of a frequency measurement.

Third, precision teachers follow the tenet 'the learner knows best' (White, 1986). Simply put, if an intervention works for a person, it is 'right' for that person. If the intervention does not produce sufficient progress then a change in the intervention must occur. Stated differently, the learner's outcomes define best practice rather than theories, beliefs, or cherished practices.

Fourth, precision teachers display all data on a standard celeration chart (SCC). As the main tool of the precision teaching process, the SCC guides all decision making. The next section provides more information on the standard celeration chart. For more information regarding precision teaching the reader can examine the following sources (Binder & Watkins, 1990; Lindsley, 1990b; Maloney, 1998; McGreevy, 1983; Potts, Eshleman, & Cooper, 1993; West, Young, & Spooner, 1990; West & Young, 1992; White, 1986; White & Haring, 1980).

Thus, the tenets of precision teaching from the corpus for an efficient, empirically based performance-monitoring system. Although the extensive literature of precision teaching has traditionally addressed mainly school-related behaviors, a growing database exists which demonstrates the success clinicians and researchers have had applying precision teaching to create dynamic rehabilitation outcomes for people with TBI (Kubina, Ajo, Mozzoni, & Malanga, 1998; Kubina & Eachus, 1994; Kubina & Hoch, 1995; Merbitz, Cherney, & Marqui, 1992; Merbitz, King, Bleiberg, & Grip, 1985; Merbitz, King, Cherney, Marqui, Grip, & Markowitz, 1992; Miller & Merbitz, 1982; Morrell & Kubina, 1999).

SPECIAL FEATURES OF PRECISION TEACHING

Precision teachers function as what Barlow, Hayes, and Nelson call 'scientist-practitioners' (1984). With direct and continuous measurement of performance, teachers become students 'of the pupil's behavior, carefully analyzing how the behavior changes from day to day and adjusting the instructional plan as necessary to facilitate continued learning' (Lindsley, 1992). The close contact a teacher has with student performance facilitates informed decisions about a learner's progress. By individualizing instruction for each student, very high performance gains occur. Precision teaching includes the following special features and advantages.

(i) A pinpoint, or precise description of the action/object, specifies where instruction begins in the areas of academic and social skills (McGreevy, 1983).
(ii) Assessment and practice typically occur in one minute sessions. These short assessment periods have demonstrated great sensitivity for measuring behavior (Lindsley, 1990a).
(iii) Daily progress is always charted on a standard celeration chart (McGreevy, 1984; Pennypacker, Koenig, & Lindsley, 1972). Standard celeration charts also come in weekly, monthly, or yearly charts. Individuals can purchase standard celeration charts from the Behavior Research Company, Box 3351, Kansas City, KS 66103, USA.

(iv) Decision rules establish and determine when instructional, treatment, or curriculum changes should occur.
(v) Both group and individual programs or projects are easy to manage and display (Cooper, Kubina, & Malanga, 1998).
(vi) The focus is on building tool skills, or basic elements of complex skills, to fluent levels. For example reading, writing, spelling, and mathematics comprise compound skills based on proficiency in element behaviors. Fluency, or automatic performance, in the elements facilitates performance in the compound. Sometimes high fluent element behavior occasions spontaneous, untaught, occurrences of the compound (Binder, 1996; Haughton, 1972; Kubina, 1999a; Johnson & Layng, 1992). This nonlinear, constructional approach offers salutary intervention to people who typically lose functioning in basic areas of functioning.
(vii) Measure frequency for REAPS. The REAPS acronym describes frequency performance standards that produce five outcomes: retention of content or skills for significantly long periods of times; endurance or resistance to fatigue; application or transfer of skills to new environments; performance aims or teaching goals; and stability or resistance to environmental distraction (Binder, 1996; Haughton, 1972, 1980; Lindsley, 1990a, 1995).

The Standard Celeration Chart

Precision teaching uses a graphical display to analyze data and make subsequent decisions. The multiply/divide chart on the SCC appears fundamentally different from charts that use add/subtract axes only. These differences include accurately, and numerically, representing variability (McGreevy, Thomas, Lacy, Krantz, & Salisbury, 1982; Spooner & Spooner, 1983). The SCC also guards against distortions in data produced by 'stretch-to-fill' charts and broken axes (Graf, 1989). For instance, changes on a graph with equal-interval or an add/subtract axis can show a significant change whereas the same data displayed on an SCC, with its proportional or multiply/divide axis, depicts little or no change (Kubina, 1999b). Last, the SCC allows the emergence of a behavior's unique 'learning pictures' (Lindsley, 1990b).

The vertical axis is scaled with a series of numbers from 0.001 to 1000. These numbers represent the range of frequencies displayed on the chart: from 1 per day to 1000 per minute. On the horizontal axis a series of numbers range from 0 to 140, which represent the total number of days in 20 weeks. The chart design originally included 140 days to allow coverage of one school semester. The chart is standard because a trend line drawn from the bottom left corner to the upper right corner has a 34° angle and equals a doubling in frequency every week (Pennypacker *et al.*, 1972).

For example, three counts of behavior appear in Figure 1, a computer generated standard celeration chart. The dots on the top half of the chart display a frequency of correct answers to SAFMEDS cards in 1 minute. SAFMEDS, discussed later, form an instructional method of learning facts or information (Potts *et al.*, 1993; Graf, 1994). The crosses plotted with the dots display incorrect answers to the SAFMEDS cards. The large line with an angle at the end represents a phase change line indicating a change in conditions. So the first cross after the phase change line shows two correct answers in 1 minute. The cross on the plus sign on the same line shows one incorrect answer in 1 minute.

The crosses on the bottom half of the standard celeration chart show questions asked in 16 hours a day frequencies. Because the data appear plotted in real time and in 16-hour frequencies, the horizontal lines (shown as a tick mark) and the corresponding value change. For example the tick mark at the bottom of the page that reads 0.001 would represent a count of 1 in a 16-hour period. The next tick mark, displaying 0.01, shows 10 per 16 hours. Following the 0.01, 0.1 show(s) 100 per 16 hours. Each succeeding tick mark signifies a growth of 100 (i.e., 200, 300, 400 and so on per 16 hours). Thus, the first cross on the bottom half of the chart represents 292 questions on that day. The crosses can be placed on the chart with the aid of a 'celeration finder' if necessary. After exposure to the chart, data become easy to interpret, even without a celeration finder.

A celeration (which comes from the root word of acceleration and deceleration) course becomes apparent as successive correct and incorrect frequencies are placed on a chart. Two celeration courses result when drawing trend lines through the correct and incorrect performances. The celeration is then uniformly identified by their angle value that shows how the performances multiply or divide per week (e.g., $\times 1.3$, $\times 2$, $\div 1.4$, $\div 2.3$). The standard celeration chart also has advantages over most add–subtract graphs in that data on the standard chart appear in calendar time that does not graphically distort behavior change and variability (Graf, 1989; Kubina, 1999b).

PRECISION TEACHING AND TBI REHABILITATION

Many of precision teaching's features that have proven valuable to teachers can augment the measurement of clinical outcomes. Merbitz *et al.* (1992) note that to obtain effective clinical outcomes, an individual therapist must employ a measurement system that gives feedback on the status of an intervention on a target behavior. Precision teaching allows therapists to monitor their

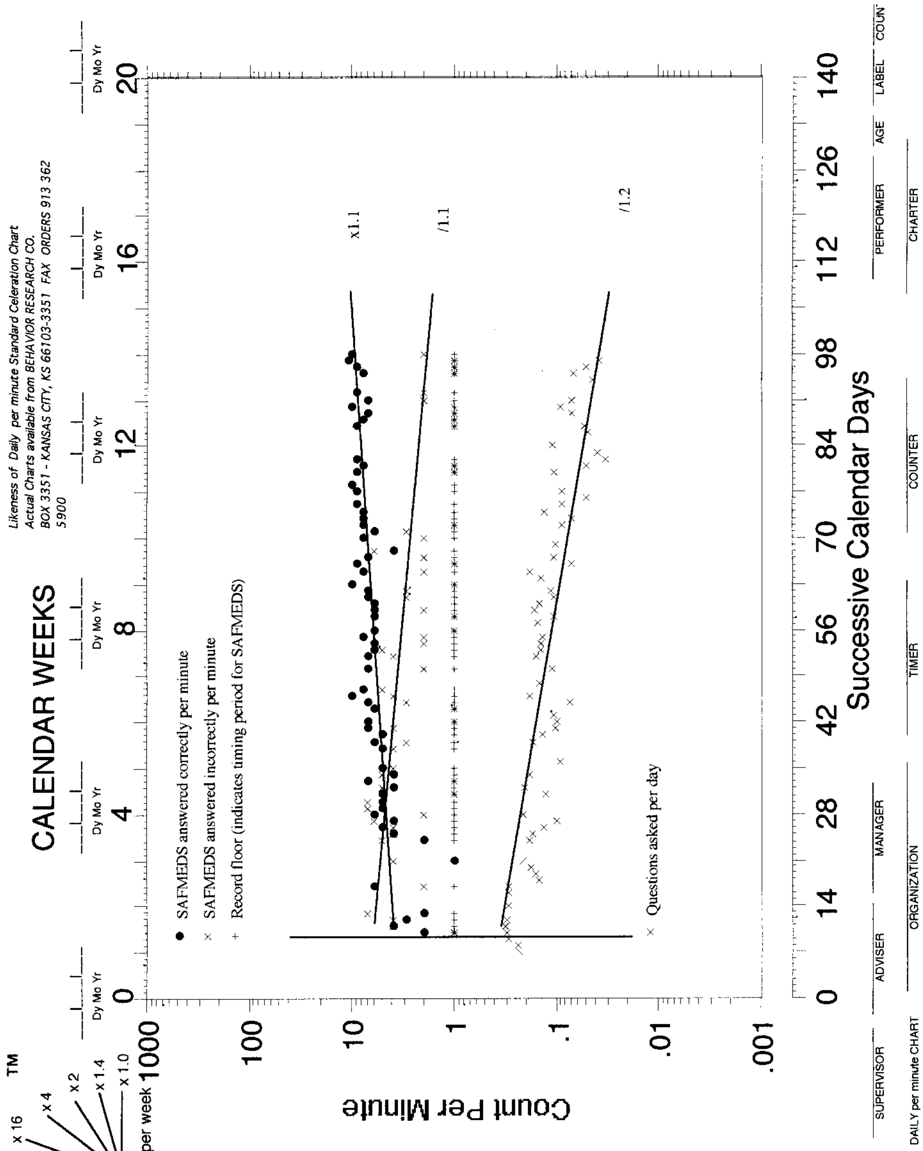

Figure 1. A daily standard celeration chart representing the SAFMEDS intervention made with a person with a traumatic brain injury.

interventions with great precision through direct and continuous measurement of objectively defined target behaviors.

Learning to use the standard celeration chart and precision teaching techniques does not appear complicated. Primary grade children chart their own performance and make databased decisions in a short amount of time (Bates & Bates, 1971). In addition, participants ranging up to senior citizens have demonstrated that they can learn and benefit from the chart (Kubina, Haertel, & Cooper, 1994). Once learned, clinical and direct care staff can share a standard method for monitoring the growth and progress of outcomes of any intervention.

Another advantage of precision teaching is the time and cost savings. Time savings occur when rehabilitation outcomes develop rapidly because of constant supervision and subsequent changes made during the intervention. Subsequently, if a therapist or other staff member is not following the therapeutic protocol, the client data will immediately reflect this effect. Further, precision teaching facilitates decisions such as the discontinuation of ineffective treatment by communicating, through a visual display of the data, to all treatment team members that a new or modified intervention is warranted. The attainment of treatment goals at an accelerated rate equals time and cost savings for the person with a TBI, the professional staff directing the rehabilitation regimen, and the funding source.

The communicative benefit of precision teaching procedures offers augmented communication among treatment providers. Direct care staff can visualize the graphic progress of treatment that they often do not meet. The standard display also sets the occasion for input from anyone on a multidisciplinary team. So, discovery of exemplary days when significant treatment gains occur can be readily identified and subsequently studied to determined important factors or treatment variables contributing to the performance (Lindsley, 1994).

CASE STUDY

A nonacademic case study illustrates one method of using precision teaching in rehabilitating people with traumatic brain injury. As clinical treatments demand prompt and informed decision making, this case study demonstrated how the major tenets of precision teaching apply to a rehabilitative outcome.

The participant, a 44-year-old man, acquired a traumatic brain injury secondary to a motor vehicle accident in 1991. He had been in a coma for 8 days after his injury. A CAT scan displayed a left intraventricular hemorrhage and left cerebral hemorrhage/contusion. Sequelae included extreme memory difficulties, restlessness, irregular sleeping patterns, disorientation, and intermittent aggression.

At the time of the intervention the participant was 3.5 years post-injury. He had received neuropsychological services for approximately 1 year. At the termination of neuropsychological services the participant received limited speech and language therapy (i.e., orientation group and a memory book with periodic evaluations by the speech pathologist). He also received physical therapy and limited occupational therapy.

A rehabilitation team consisting of a neurologist, neuropsychologist, speech-language pathologist, occupational therapist, physical therapist, and a special education teacher initially evaluated the participant. A behavior therapist collaborated with the team members and designed individual approaches tailored for the participant. Consent was obtained from the participant and he received information about the procedures used during sessions.

Before the traumatic brain injury the participant was described by significant others as having ‘average intelligence and a good memory’. After the cerebral insult the participant presented profound retrograde amnesia and anterograde amnesia. The client could not remember much of his adult life and had great difficulty remembering his wife and children. He did have recall of his earlier life, and occasionally believed he was still living in that period.

The participant lived in the present moment and could not remember the past nor what might happen in the future. These effects of the diffuse amnesia restricted the participant’s orientation and quality of life greatly. He would continually ask questions such as ‘Will I be staying here tonight?’ and ‘Where do I go next?’. If not given an answer he would become agitated and, on occasion, aggressive.

A memory book served as the primarily means for treating memory deficits. At best, this compensatory strategy permitted the participant an immediate answer to his questions. Unfortunately, many times he would forget to check his memory book. On those occasions when he forgot and asking an orienting question, the staff would remind him of his memory book. Although the strategy appeared well intended, it did not address the retrograde deficits and only indirectly addressed the anterograde deficiencies.

Baseline

Before baseline began the behavior specialist, the first author, met with the participant’s wife, speech pathologist, and neuropsychologist to discuss a new approach to treatment. After soliciting input pertaining to the goals of intervention, assessment of current memory deficits began.

The baseline phase consisted of taking a daily frequency count of orienting questions (e.g., 'Am I staying here tonight?'; 'Do I have a session?'). All staff at the rehabilitation center participated in a comprehensive training period that lasted approximately 2 weeks. After staff members gained data collection competencies, they assessed how many orienting questions the participant asked throughout the day. The staff used a small hand held counter which had the capacity to display a count of 9999 occurrences of any behavior. When the participant asked a question, the staff would discreetly depress the lever on the counter. The staff received instructions to answer the participant honestly if he asked about the counter.

Intervention

The intervention consisted of SAFMEDS, an acronym for 'Say All Fast a Minute Every Day Shuffle' (Potts *et al.*, 1993; Graf, 1994). SAFMEDS assist individuals in attaining fluency, or mastery, with a given set of information points by presenting the content on small cards in a cumulative, systematic, and varied fashion. The cards look similar to flashcards but differ in that the person (i) says the answer to the card, (ii) works with all of the deck and not part of it; (iii) goes through the deck as quickly as possible; (iv) timed assessment consistently lasts for 1 minute; (v) has an assessment and practice session occur every day, and (vi) learns the deck of cards by shuffling and not learning in serial position.

The participant used a small SAFMEDS deck of 40 facts that contained the answers to anterograde and retrograde amnesiac questions that the participant asked throughout the day. For instance, some of the facts related to the participant's schedule (e.g., front of card: At 9 am I go to ____; back of card: current events group). Other facts related to how long the participant had been at the facility or why he was there (e.g., front of card: I have been a client at this facility since: ____; back of card: 1991 after my car accident).

Typically, people using SAFMEDS manipulate the cards themselves so they can respond at their own rate. Because the participant had ataxia severe enough to interfere with successfully manipulating a SAFMEDS deck, the therapist held the cards and presented them to the participant. The participant began responding to the behavior specialist's signal (e.g., 'Please begin when I say go'). The behavior specialist started the timer by pushing a button and would say 'go' and present the SAFMEDS. The participant would read the card orally and attempt to answer it in a 1 minute interval. During the initial sessions it was explained to the participant that if he could read the card silently, he would progress through the deck more rapidly. His anterograde amnesia, however, interfered with successful attainment of this goal so the prompting was ended. He continued to read and respond orally to the SAFMEDS cards.

A 5 second latency criterion limit existed for the participant to answer the card. If he did not answer the card in this time period, it was put aside and recorded as a miss. This limit was set to increase productivity. If the SAFMEDS presentation was not at a brisk pace, the participant would attempt to answer a fact that he did not know using the entire 1 minute interval. Sessions lasted approximately 30 minutes with the best score reported on the standard celeration chart. Best scores appeared on the chart to accentuate the positive growth and hard work the participant put forth. After the session ended both the participant and behavior specialist reviewed the chart and discussed the progress made.

Results

Figure 1 displays a computer-generated standard celeration chart for the participant. There are two behaviors charted. First, the upper behavior is the SAFMEDS intervention. Dots ($\cdot$) represent the correct responses and crosses represent incorrect responses. The plus symbol at the bottom of each daily count, called the 'record floor', signifies the length of the observed behavior. So for the SAFMEDS intervention, the record shows that the performance occurred for 1 minute on a given day. The other behavior displayed on the standard celeration chart is the count of question asking behavior. Each cross represents targeted orientation questions asked to people in the neurorehabilitation center. The record floor signifies a 16 hour count.

Baseline data ranged from 315 to 292 questions asked per day. The celeration for baseline was $\times 1.0$, or no growth of the behavior. The data for the SAFMEDS intervention, whose implementation is indicated by a phase change line, show that correct responses accelerated, or multiplied, by $\times 1.1$. Incorrect responses to SAFMEDS decelerated, or divided, by $\div 1.1$. During the intervention, question asking ranged from 392 to 31 and decelerated by $\div 1.2$.

DISCUSSION

The preceding case study illustrates how precision teaching can heighten the effectiveness of therapeutic efforts. A 44-year-old man who suffered a severe head injury experienced significant impairment through retrograde and anterograde amnesia. The subsequent effects of the two conditions restricted his residence to a highly structured environment and reduced the quality of life for the participant and his family (e.g., the client had difficulty remembering his wife, family members, and significant others in his life).

After the intervention the participant asked ten times fewer questions a day, a general reduction from 390 to 39 orienting questions asked per day. The result from the precision teaching intervention appears to have mitigated the disorientation effects of the amnesia. The participant 'knew' the answers to the questions he so frequently asked. Further it appeared he now had a better semblance of what his day would consist of, what had happened to him, and the members of his immediate family. It seems unlikely to attribute the effects to spontaneous recovery because the participant was over 3 years post and the intervention documented gradual change over a 3 month period.

The use of precision teaching in this case study suggests one possibility of application to clinical interventions. Other implementations of precision teaching, not reported, included re-teaching an individual to tell time, remediating handwriting, accelerating vocal sounds and beginning speech, re-teaching decoding, comprehension and reading, re-teaching mathematic computation and reasoning skills, teaching social skills, monitoring effects of medications, monitoring attending behaviors, and decelerating inappropriate physical and verbal behaviors (Kubina, 1997).

If a person can observe and count a behavior, then the behavior lies in the realm of change. Namely, a person can apply systematic changes to accelrate or decelerate a behavior. Individual clinicians or members of a treatment team using precision teaching rapidly learn what techniques work and which do not. Thus, a systematic and databased method for facilitating therapeutic decisions develops. Precision teaching has many other applications in clinical settings.

(i) Each individual's problem is unique, and specifically tailored therapies can be arranged and monitored effectively.
(ii) It allows measurement of fluency for constructive goals. Participants who attain fluency of a target behavior benefit with REAPS.
(iii) Monitoring progress on a standard celeration chart allows the participant direct feedback, is motivational, and expands the therapeutic team.
(iv) Standard displays of treatment can be compared and scrutinized in absolute measures (i.e., frequency and celeration).
(v) It saves time for individuals with traumatic brain injury, therapists, and others involved in implementing and maintaining therapeutic programs.
(vi) It circumvents plateaus or ceilings artificially induced by inferior or subjective measurement systems.

CONCLUSION

Traumatic brain injury rehabilitation is a growing field. Under the lens of managed care rehabilitation methods and practices will most certainly come under increased scrutiny. While the answers to producing the most cost and time effective intervention do not seem easy, a performance monitoring system such as precision teaching offers a host of advantages. For these benefits to come to fruition, however, research and wide-scale implementations must first occur.

The use of precision teaching has produced extraordinary changes in public schools (Beck & Clement, 1991), private schools (Johnson & Layng, 1994; Maloney, 1998), colleges (Johnson & Layng, 1992), corporate training (Binder & Bloom, 1989), and a multitude of personal, academic, and social implementations too numerous to list. Precision teaching has worked so well because of its inductive, objective, empirical, and scientific nature. And just as the use of science and scientific procedures have produced exceptional and unprecedented advances in the lives of humans, so too may one day precision teaching contribute to the field of traumatic brain injury rehabilitation.

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