PRECISION TEACHING: THE STANDARD CELERATION CHARTS

ABIGAIL B. CALKIN, PH.D.
PRIVATE PRACTICE

Combining Pavlov's (1960/1927) use of frequency as a standard unit in the measurement of scientific phenomena and Skinner's (1938) use of frequency, free operant behavior, and the cumulative recorder with his knowledge of engineering and interest in navigation, Lindsley brought to psychology and education the most powerful and scientific use of measurement applied to human behavior. In 1965, he developed what was first called the Standard Behavior Chart, now more accurately described as a family of Standard Celeration Charts—standard measurement charts for human behavior in daily, weekly, monthly, and yearly time periods. This paper provides an overview of these four types of Standard Celeration Charts.
Key words: Precision Teaching, Standard Celeration Charts, frequency, continuous measure, behavior therapy

Since 1967, educators and others have used the Standard Behavior Chart (now called the Standard Celeration Chart) to observe human behavior and improve learning. The people behaving have ranged from fetuses to those in their 80s (Calkin, 1983; Cobane & Keenan, 2002; Edwards & Edwards, 1970). Some behaviors counted have included all day counts of fetal movement (Calkin, 1983), positive and negative feelings about self (Cobane & Keenan, 2002; Kostewicz, Kubina, & Cooper, 2000; Kubina, Haertel, & Cooper, 1994), as well as the more usual 1-minute timings of academic behaviors such as Hear Say question then answer (Zambolin, Fabrizio, & Isley, 2004), See Write math facts (Stromberg & Chappell, 1990), Think Say and Think Write American government facts (using 1-minute, 2-minute, and 5-minute timings) (Ellis, 1980), Write words (Albrecht, 1981), and See Say parts of a microscope or skeleton (Miller & Calkin 1980).

FREQUENCY AND CELERATION

Because of the design of the Standard Celeration Charts—the standard is the 34 degree angle of the doubling line from corner to opposite corner—all *ac*celerations and *de*celerations are standard on all charts. Behavior Research Company publishes the series of Standard Celeration Charts for minutes, days, weeks, months, and years. Lindsley trade marked the term "Standard Change Chart" to describe general applications of the chart series.

Using the Standard Celeration Chart makes two critical elements apparent. First, behavior grows by multiplying, *not by adding.* If Janel wants to improve her learning, she knows that to grow from one to two is to double and is identical to growing from 50 to 100, not from 50 to 51. When she wants to learn something new or change a behavior or feeling, she wants change by doubling, not by adding or deleting one at a time. If Abigail says 35 Russian conversation words in one minute (to which no Russian will listen for long!) and grows by adding one a day, it will take 215 days, or 31 weeks, to reach fluent speech. If she learns by doubling each week, she can get from 35 words per minute to 250 in 50 days, or seven weeks. If Gemma is a slow reader and reads 62 words a minute at grade level and wants to read 200 words per minute, does her teacher want her to grow by adding or multiplying? If Alan has 100 suicide thoughts a day, does he want to reduce them by one or two per day or by ÷5.0 per week?

Secondly, the chart makes us look at not only the *frequency* of a person's performance, but also at the *growth of learning across time*, (i.e., the *celeration)*. Within the first five years of using the chart, several of its powerful elements became increasingly apparent. Frequency is performance: It tells what happened during one time period, but by itself it tells little about learning. To see whether performance accelerates or decelerates, we need to measure it across time. Since 1971, we have called this change in learning celeration.[1] Acceleration indicates an increase in the growth of change of the frequency, in the learning of the behavior. Deceleration indicates a decrease in the learning of the behavior.

Frequency is the count per minute: the number of times Steve does independent or dependent actions per hour; the number of pieces of science equipment Greg names correctly and incorrectly in one minute; the number of

1 *Celerare*, a Latin verb meaning to hasten, is the root of *acc*elerate and *de*celerate. Accelerate has as its root, *accelerare*, to hasten toward. *Decelerare* would mean to hasten from. *Celer*, an adjective, means quick or swift; the Latin adverb is *celeriter, celerius, celerrime*. Another English word from this same root, celerity, means rapidity of motion or action.

words Chris reads correctly and incorrectly per minute; the number of pleasant and unpleasant self-thoughts Angie has per day. These behaviors show *performance*.

Celeration is the count per minute per week. It shows change in performance, or *learning* across time. We measure celeration, (i.e., learning) by the week, or, if using larger time measures, changes by the month, year, or decade. Celeration: Steve's actions per hour, each day, per week; Greg's pieces of science equipment he points to and says per minute, each day, per week; Chris's words read per minute, each day, per week; Angie's thoughts about self per minute all day, each day, per week.

Most graphs give only the frequency at best, and often the graph represents a removal of the original data, replacing it with a percentage or rate. The Standard Celeration Chart displays the original data. Because of its design, the charter plots only frequency so the chart always displays performance within a time period. Further, if desired, one can read percentages from the Standard Celeration Chart. If Janel had zero errors, she had 100% correct answers. However, this gives no idea how many correct answers she said. In fact, Janel began with four answers correct per minute with heavy prompting from her tutor. With direct teaching two hours a week, she learned to say 28 correct answers per minute, also 100%, with no prompts after only five lessons and three weeks later. A percentage tells me her learning has not changed. The raw data charted on a frequency scale lets me know she has grown, celerated, by x7 over three and a half weeks. With "guided" written above the timing of the four per minute, Janel had gone from heavy prompts in the first lesson to no prompts five lessons later.

In 1980, Steve, an 18-year-old high school senior, returned to school each Monday with low frequencies of independent actions (e.g., working without teacher direction, coming up with ideas without prompting) and high frequencies of dependent actions (e.g., asking for teacher help, starting only when told). Cindy Bartels, his teacher, and Steve counted these each hour he was in her history class. The Monday through Friday pattern jumped out. Bartels learned Steve had no home supervision on the weekend and returned to school each Monday, even at 18, behaviorally saying, "Please give me order." At the end of week 2, Bartels helped him see he had to provide his own order every day, an essential since he was about to graduate and would suddenly require a lot more self-direction. After Bartels shared the data with Steve and discussed the weekly pattern with him, his independent actions increased and his dependent actions decreased. By midweek during weeks 3, 4, and 5, the frequencies had reversed and the independents were high, the dependents at zero.

STANDARD CELERATION CHARTS

The *Daily Standard Celeration Chart* measures any human behavior that occurs on a daily basis. It ranges from .00069, or one time per 24-hour day, up to 1000 per minute (which will cover words read silently and rapid eye blinking should you wish to count that). It has one behavior per day at the bottom, one behavior per minute in the middle, and 1000 behaviors per minute at the top. Any line drawn parallel to the corner-to-corner line means learning has changed by x2, an acceleration or improvement. From the top left to the bottom right the change is a ÷2, a deceleration, an improvement when errors, inappropriate behaviors, or negative inners, for example, are counted.

Daily Chart

The Daily Chart has 140 days across the bottom and the darker blue vertical lines are Sunday lines. All the days line up Monday through Sunday, just like life. If weekends off produced a change in learning, as it did with Steve, we can see that. Three categories of daily behavior are often measured and include: 1) academic learning—e.g., Grasp Release an object, See Say (read aloud) words, See Say (memorize) musical notation or the Periodic Table, Think Say facts from text in order (also called Free Say where the stimulus is unknown); 2) other outer behavior such as being out of seat, interrupting, greeting people, setting goals, making free choices; and 3) inner behaviors such as thoughts of a former wife, jealous feelings, positive and negative feelings about one's marriage, pleasant and unpleasant feelings about oneself. The Daily Chart in Figure 1 shows Greg learning science facts by See Say—he *sees* the object and *says* its name or he *sees* the front of the flashcard and *says* the information on the back.

In four of the five phases, corrects accelerate (by about x1.8, or an 80%, increase per week) and the errors decelerate, most dramatically in the first phase by a ÷10 per week. In the third phase, Science Facts #1 (Flash Cards) No Study, corrects and errors both increased. Seeing from a collection of charts that learning was not occurring well for about fifteen of her 19 students, Miller and Calkin, (1980) made the decision to add five minutes of study time. The students' correct responses continued to accelerate and their errors began to decelerate. As you can see in Figure 1, Greg's performance was no different, his corrects began to accelerate while his incorrects began to decelerate. Because the chart is standard, Miller could quickly see whether each student was learning and could tell whether she had made the correct teacher

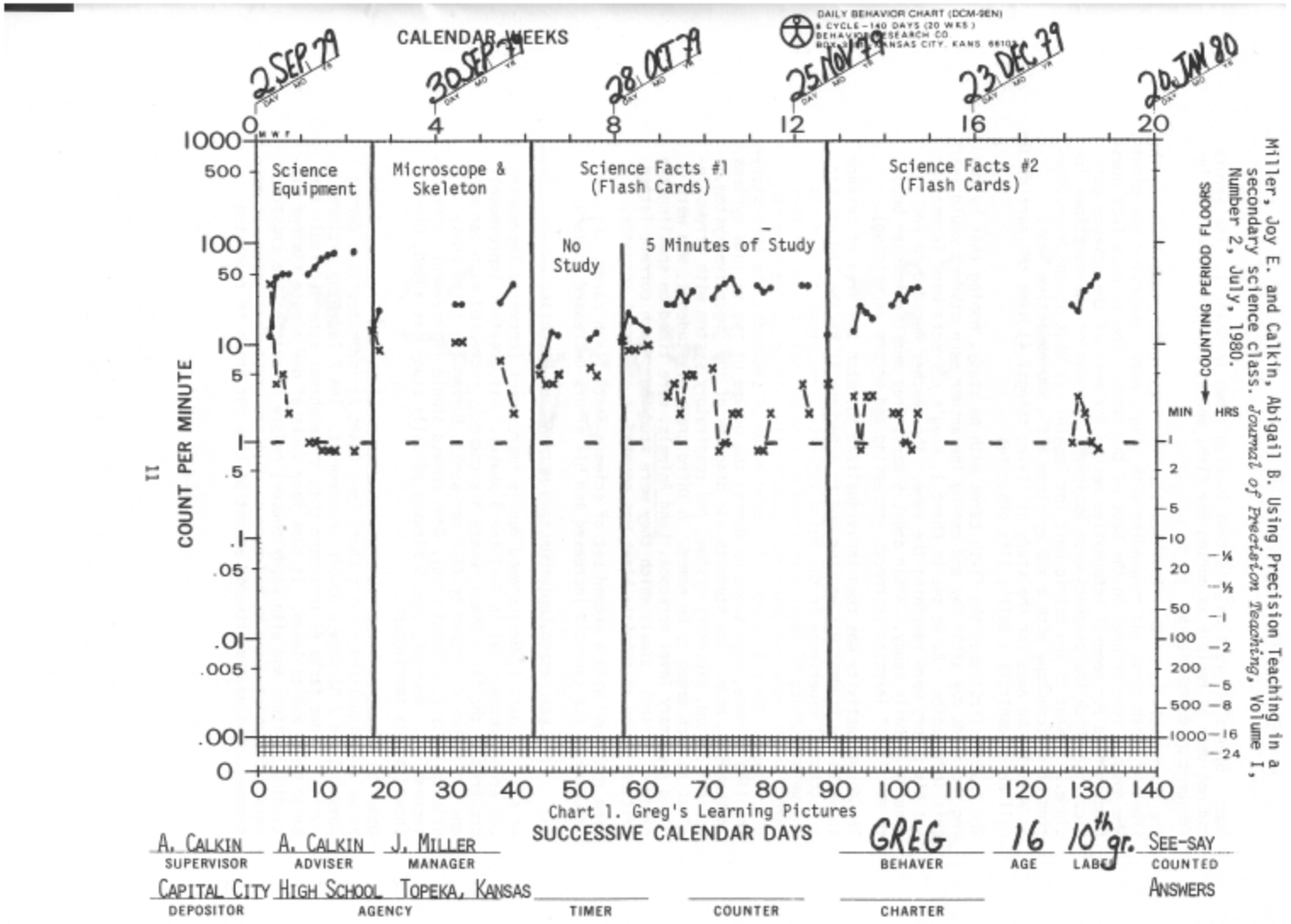

Figure 1: Number of correctly and incorrectly identified science facts

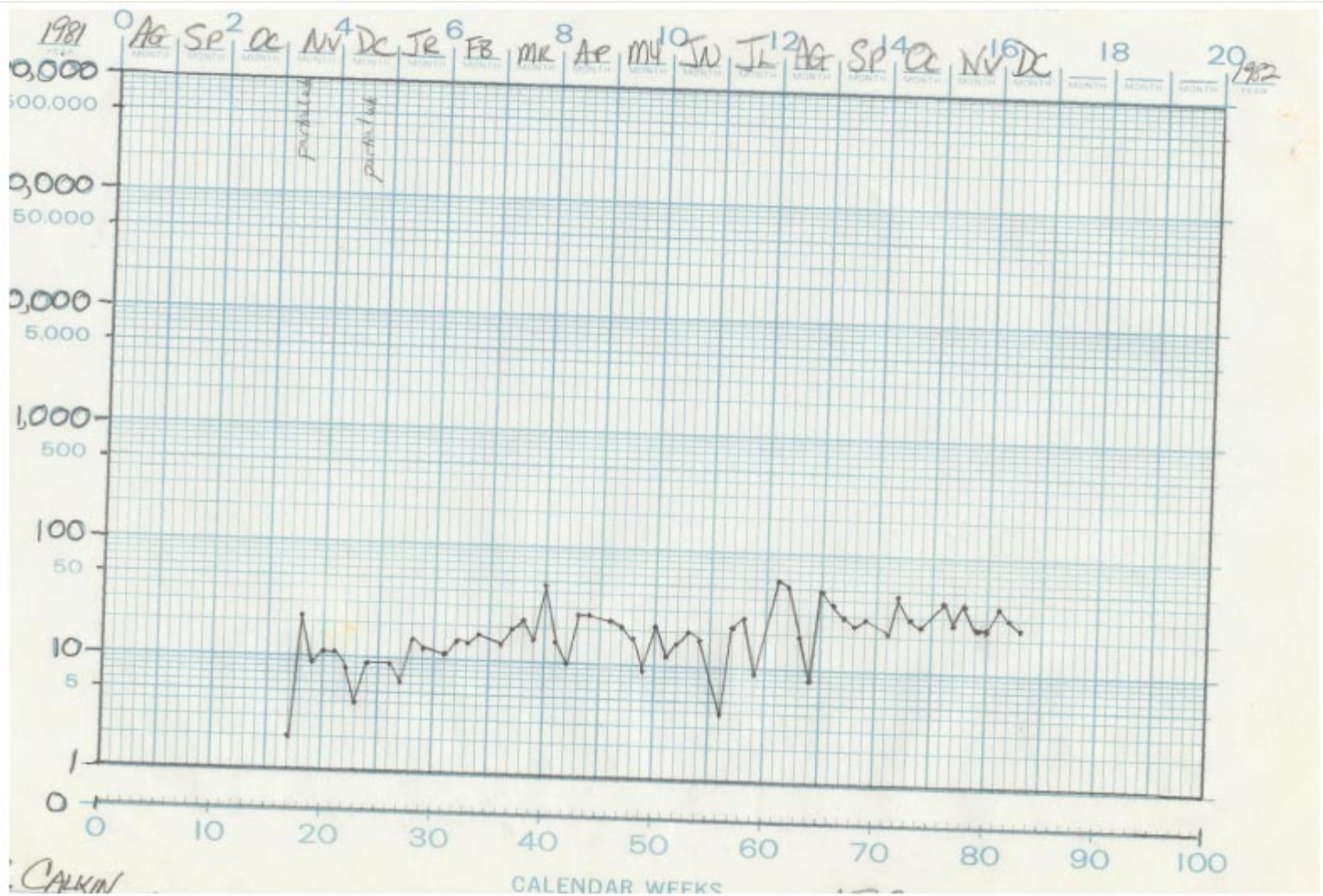

Figure 2: Abigail's illusions per week

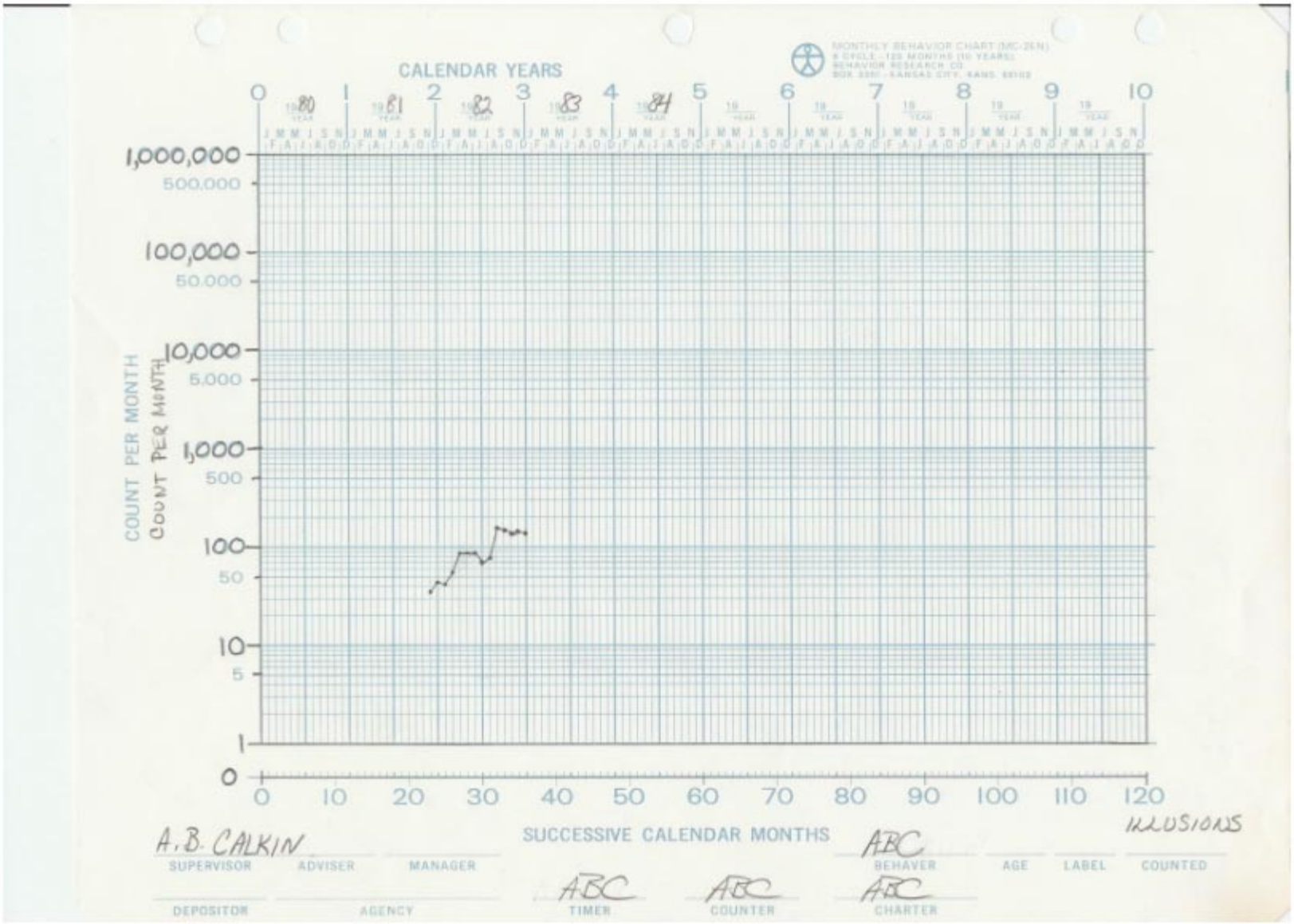

Figure 3: Abigail's illusions per month

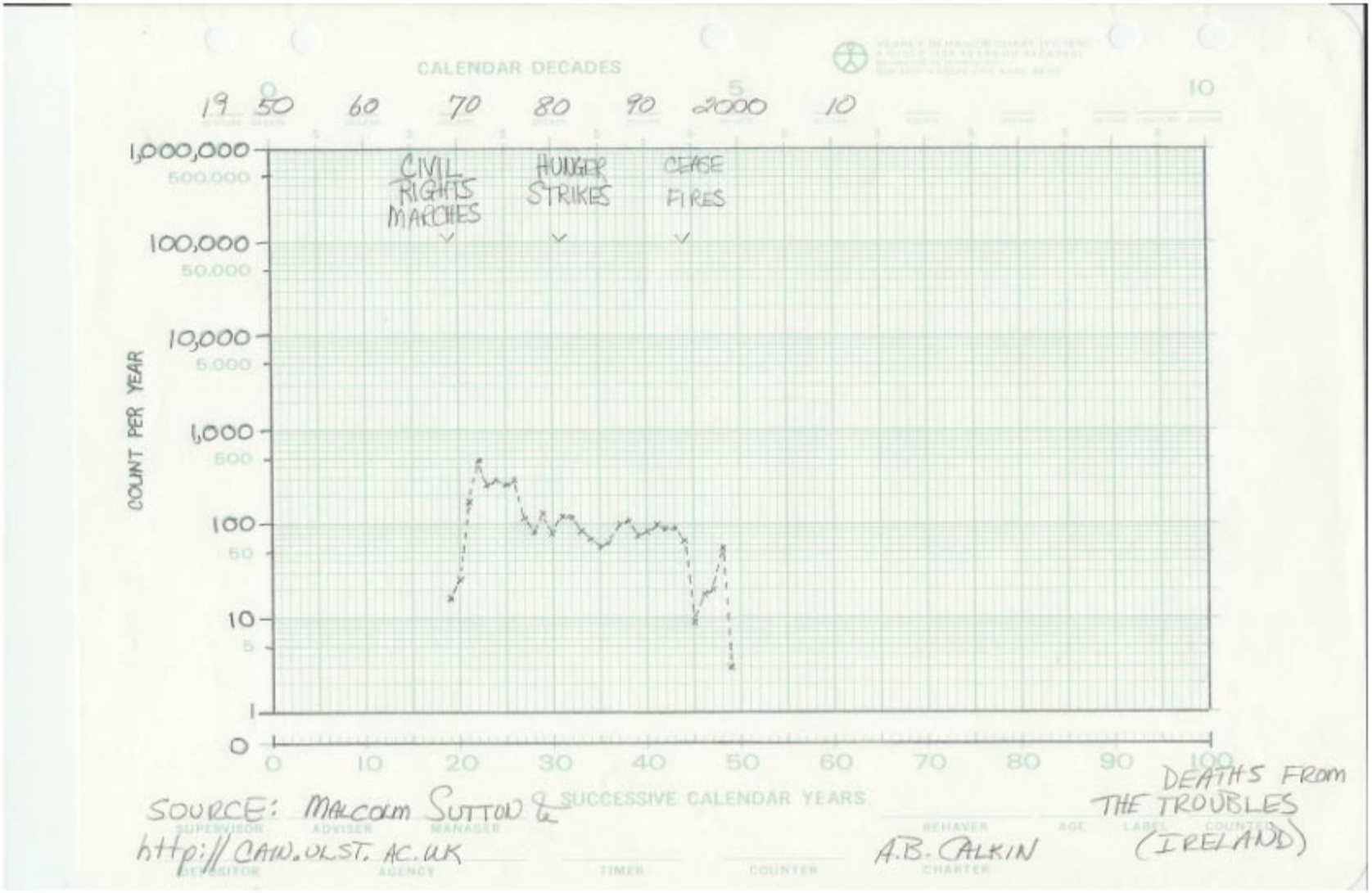

Figure 4: Number of people killed during the “troubles of Ireland”

decision.

Weekly Chart

The *Weekly Standard Celeration Chart* is often used to measure behaviors of an organization or its people when such data are most clearly summarized on a weekly basis. Any daily behavior occurring from not at all to up to perhaps three or four times a day we best see totaled for the week and put on the Weekly Chart. Performance on the Weekly Chart goes from one per week up to 1,000,000 per week. We measure celeration on the Weekly Chart by the month. The Weekly Chart in Figure 2 shows Abigail's illusions per week. An *illusion* is an image, a phantasma, or a sensory image that appears but the person having it knows that is not real. It is a stimulus that exists alone; other than to note its occurrence, Abigail had no response to it unless she thought it may have some potential literary value and record it for later use in a poem or story. An example is seeing three men, dressed in clothing of 1900, digging a sizeable hole in the street—their street is dirt, the one she is on is paved—and they weren't there five seconds earlier. She had counted 12 behaviors daily for 13 months; some of these were of low frequencies and best displayed on a weekly or monthly chart. Her illusions gradually increased at X1.1 per week. Looking at the same data on the monthly chart, the acceleration is more evident, doubling every six months.

Monthly Chart

Like the Weekly Chart, the Monthly Standard Celeration Chart may also be used to measure the growth and change within an organization such as a business, school, or family. Performance on the Monthly Chart goes from one per month up to 1,000,000 per month. We measure celeration by the half years. The Monthly Chart in Figure 3 shows Abigail's monthly illusions. The first month the data were charted, illusions occurred slightly over 30 per month. Illusions accelerated across the next 9 months peaking at 90 per month for three consecutive months. The tenth month had a jump-up to approximately 170 illusions per month decelerating slightly to approximately 140 illusions per month.

Yearly Chart

The *Yearly Standard Celeration Chart* usually measures business, school, family, political, economic, social, historical or ecological changes. Performance on the Yearly Chart ranges from one per year up to 1,000,000 per year. We measure celeration every five years. The Yearly Chart in Figure 4 shows the number people killed during The Troubles (of Ireland) from 1969 to 2001 (Sutton, 2003). The Civil Rights marches began in 1969 and across the next 4 years the deaths in Ireland dramatically increased from 17 in 1969 to almost 500 in 1972, their highest level in 31 years. By 1977, deaths per year had decreased to about 100 per year and maintained between 60-120 deaths per year for 18 years before decelerating in 1995, the year after the cease fire was declared. The hunger strikes of 1981 had little to no impact on the total number of deaths per year.

SUMMARY

The paper presented four charts — daily, weekly, monthly, and yearly. Using the Standard Celeration Chart has a number of advantages to conventional add-subtract charts typically used in behavior analysis and education. First, because the Standard Celeration Chart uses a standard scale to display change numerically, when you looked at each of these charts, you can tell immediately whether the line went up, down, or stayed the same. If you don't already have the thought as to which line was the steepest, go back to any chart for a second look, the steepness (i.e., slope) of the line changes not because of a differently graphed scale on the left or across the bottom but because the behavior changed. Second, since each form of the Standard Celeration Chart is by definition standard, to read one Standard Celeration Chart is to have the ability to read any of them. The vertical axis on all standard charts multiplies by 10 and performance from corner-to-corner (i.e., bottom left to upper right) is interpreted based on a doubling of performance, or X2. Therefore, the ability to read one chart means one has the ability to read all charts providing information to make informed decisions across many different venues.

Lindsley began to measure the behavior of schizophrenics at Metropolitan State Hospital in Waltham, Massachusetts, and coined and first published the term "Behavior Therapy," in the 1954 Boston telephone directory: Studies in Behavior Therapy (O. R. Lindsley, personal communication, October 11, 1999). In 1967, Lindsley formed the Behavior Bank to collect, analyze, summarize, and display facts about human behavior (Koenig, 1972). Banked projects include academic, personal management behaviors, and inner behaviors. *Handbook of Precise Behavior Facts* (Lindsley, Koenig, Nichol, Kanter, & Young, 1971) contains summaries of 11,947 Standard Celeration Chart projects on peoples' learning. Volume I lists each pinpoint, the body part involved, the supervisors and contributors of the projects, the instructional technique, and the reward or punishment

for each project. Volume II displays the visual summary of the data for any pinpoint which had at least five charts banked; the highest, middle, and lowest frequency; and the most rapid (i.e., steepest), middle and the slowest (i.e., flattest) celeration. By 1973, the Behavior Bank contained 16,376 projects (Sokolove, 1973). The Behavior Bank closed in 1974 (Potts, Eshleman, & Cooper, J., 1993). However, by 2000, the vast majority of an estimated 1.2 million charts had come from education and direct work with students (Calkin, 2002).

In addition to helping students learn in regular and special education classrooms, learning centers, and universities, Precision Teaching has been used in many different fields including nursing (Dean, 1973/1974), inner behavior (Calkin, 1979/1980; Calkin, 1981; Calkin, 1983; Calkin, 1990; Calkin 1992; Calkin, 2000; Cobane & Keenan, 2002; Dean, 1973; Duncan, 1971; Judy, Malanga, Seevers, & Cooper, 1997; Kostewitz, et al, 2000; Kubina, et al, 1994), and education (Malanga, 2003; Sweeney, Sweeney, & Malanga, 2001; Teigen, Malanga, & Sweeney, 2001) to name just three. Precision Teaching has also had a cross-cultural influence as well and has been used in multiple countries including the United States, Northern Ireland, Australia, and Canada. The field now is shared across these and other countries via the Internet. Precision Teachers meet online at SClistserv@lists.psu.edu and has its own website www.celeration.org. In addition to these two resources, there are a number of useful Precision Teaching websites including: precisionteachingresource.net/, behaviorresearchcompany.com/updates/, celeration.net/, www.schoolhousetech.com/products/basicfacts/index.htm, fluency.org, fluencyfactory.com, and morningsideacademy.org. For those interested in learning more about Precision Teaching Graf and Lindsley (2002) recently published a handbook titled *Standard Celeration Charting 2002* and the *Journal of Precision Teaching and Celeration*, which began in 1980, published its 20th volume in 2004.

REFERENCES

Albrecht, P. (1981). *Journal of Precision Teaching, 2*(1), 18-21.

Calkin, A. B. (1979/1980). Measuring and comparing perceived facts, fun, and freedom. (Doctoral dissertation, University of Kansas, 1979). *Dissertation Abstracts International, 41*, 34A. (University Microfilms No. 80-14, 398)

Calkin, A. B. (1981). One minute timing improves inners. *Journal of Precision Teaching, 2*(3), 9-21.

Calkin, A. B. (1983). Counting fetal movement. *Journal of Precision Teaching, 4*(2), 35-40.

Calkin, A. B. (1990). Changes in behavior as the result of the death of a relative. *Journal of Precision Teaching, 7*(2), 74-78.

Calkin, A. B. (1992). The inner eye: Improving self-esteem. *Journal of Precision Teaching, 10*(1), 42-52.

Calkin, A.B. (2000). A Minute a Day Makes Good Feelings Grow. *The Cambridge Center for Behavioral Studies*. Available Web-site: http://www.behavior.org Icon: Everyday Life.

Calkin, A. B. (2002). Estimated number of standard celeration charts as of 2000. *Journal of Precision Teaching & Celeration, 18*(1), 33-34.

Cobane, E., & Keenan, M. (2002). A senior citizen's self-management of positive and negative inner behaviours. *Journal of Precision & Celeration, 18*(2), 30-36.

Dean, D. H. (1973). An analysis of the effects of using direct measures in a competency based professional education program: An example in nursing. (Doctoral dissertation, University of Oregon, 1973). *Dissertation Abstracts International, 34*, 5577A. (University Microfilms No. 74-6820)

Duncan, A. D. (1971). The view from the inner eye: Personal management of inner and outer behaviors. *Teaching Exceptional Children, 3*, 152-156.

Edwards, D. D. & Edwards, J. S. (1970). Fetal movement: Development and time course. *Science, 169*, 95-97.

Ellis, R.B. (1980). Measuring facts and comprehension using different learning channels. Unpublished manuscript.

Graf, S., & Lindsley, O. (2002). *Standard Celeration Charting 2002*. Poland, OH: Graf Implements.

Judy, M. L., Malanga, P. R., Seevers, R., & Cooper, J. O. (1997). A self-experimentation on the detection of forgets using encouraging think/say and hear/tally statements. *Journal of Precision Teaching and Celeration, 14(2)*, 37-46.

Koenig, C. (1972). *Charting the future course of behavior.* Kansas City, KS: Precision Media.

Kostewitz, D. E., Kubina, R. M., & Cooper, J. O. (2000). Managing Aggressive Thoughts and Feelings with Daily Counts of Non-Aggressive Thoughts: A Self-Experiment. *Journal of Behavior Therapy and Experimental Psychiatry, 31*(3-4), 177-187.

Kubina, R.M., Haertel, M.W., & Cooper, J.O. (1994). Reducing negative inner behavior of senior citizens: The one minute counting procedure. *Journal of Precision Teaching and Celeration, 9*(2), 28-35.

Lindsley, O. R., Koenig, C. H., Nichol, J. B., Kanter, D. B., & Young, N. A. (1971). *Handbook of Precise Behavior Facts*. Kansas City, KS: Precision Media.

Malanga, P. R. (2003). Using repeated readings and error correction to build reading fluency with at-risk elementary students. *Journal of Precision Teaching and Celeration, 19(2)*, 19-27.

Miller, J. E., & Calkin, A. B. (1980). Using precision teaching in a secondary classroom. *Journal of Precision Teaching, 1*(2), 10-17. Reprinted in 1997. *Journal of Precision Teaching, 15*, 44-51.

Pavlov, I. I. (1960/1927). *Conditioned reflexes*. New York: Dover Publications, 1960. Trans., G. V. Anrep.

Potts, L., Eshleman, J.W., & Cooper, J.O. (1993). Ogden R. Lindsley and the historical development of Precision Teaching. *The Behavior Analyst, 16*(2), 177-189.

Skinner, B. F. (1938*). The Behavior of Organisms.* New York: Appleton-Century- Crofts.

Sokolove, H. (1973). *Inner Behavior: The Private Eye Becomes Public Information.* Kansas City, Kansas: Precision Media.

Stromberg, G., & Chappell, M. (1990). Where have all the classrooms gone? *Journal of Precision Teaching, 7*(1), 1-4.

Sutton, M. (2003). An index of deaths from the conflict in Ireland. *Bibliographic Data Bases and Other Services.* (Retrieved April 13, 2003 from *http://CAIN.ULST.AC.UK/sutton/tables/Year.html*).

Sweeney, S. R., Sweeney, W. J. & Malanga, P. R. (2001). The effects

of one-minute warm up procedures on addition one-minute fluency timings. *Journal of Precision Teaching and Celeration, 17(2)*, 76-88.

Teigen, R., Malanga, P. R., & Sweeney, W. J. (2001). Combining repeated readings and error correction to improve reading fluency. *Journal of Precision Teaching and Celeration, 17(2)*, 58-67.

Zambolin, K., Fabrizio, M. A., & Isley, S (2004). Teaching a Child with Autism to Answer Informational Questions Using Precision Teaching. *Journal of Precision Teaching and Celeration, 20*(1), 22-25.