Treatment of Aggression with Behavioral Programming that Includes Supplementary Contingent Skin-Shock

Matthew L. Israel, Nathan A. Blenkush, Robert E. von Heyn, and Patricia M. Rivera

Abstract

Behavioral treatment of aggression with contingent skin shock (CSS) has been investigated in relatively few studies and never with cognitively typical individuals. We evaluated CSS during a 3-year period with 60 participants, half to two-thirds of whom functioned at normal or near-normal cognitive levels. Sixty individual charts, arranged in a multiple baseline across participants display, reveal clearly the effectiveness of the treatment. When end-of-baseline data were compared with end-of-treatment data, CSS, as a supplement to positive programming, showed effectiveness (defined as a 90% or greater reduction from baseline) with 100% of the participants. This compares favorably with positive behavior support procedures, which, according to the 1999 treatment outcome review by Carr at al., achieved that effectiveness standard with only 55.5% of the cases (Carr et al., 1999). Higher functioning participants showed from 2 to 6 times more reduction than did lower functioning participants. Psychotropic medications were reduced by 98%, emergency takedown restraints were reduced by 100%, and aggression-caused staff injuries were reduced by 96%. As a result of the treatment, 38% of participants no longer required CSS and some returned to a normal living pattern.

Key words: aggression, contingent shock, skin-shock, punishment

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Individuals who exhibit high frequency and/or high intensity aggressive behaviors are often treated with psychotropic medication and behavioral procedures. Unfortunately, psychotropic drugs have proven ineffective in treating the aggression of many individuals, including all of the participants in the present study. They also sometimes produce unfortunate side effects such as sedation, severe weight gain, tardive dyskinesia, neuroleptic malignant syndrome, etc.

The behavioral procedures employed in current clinical practice to treat aggression are usually limited to "positive-only" procedures such as the manipulation of positive reinforcers, the arrangement of antecedents and setting events, provision of educational procedures, and the use of decelerating procedures other than physical aversives. If such procedures prove to be insufficiently effective, the individual is likely to continue to receive high doses of psychotropic medication, may be subjected to substantial amounts of restraint or isolation, and/or may be transferred to a highly restrictive environment (Foxx, 2003).

Contingent skin-shock (CSS), when used as a supplement to other behavioral procedures, has proven effective in treating various problem behaviors that were otherwise intractable. Most of the CSS treatment studies that have been published since 1965 have involved self-injurious behaviors (e.g., Salvy, Mulick, Butter, Bartlett, & Linscheid, 2004; Linscheid & Reichenbach, 2002; Duker & Seys, 1996; and Mudford, Boundy, & Murray, 1995). Other behaviors treated have included (ordered according to the frequency with which the topic has been reported) aggression (e.g., Foxx, McMorrow, Bittle, & Bechtel, 1986); ruminating and/or vomiting (e.g., Wright, Brown, & Andrews, 1978; Cunningham & Linscheid, 1976; Toister, Condron, Worley, & Arthur, 1975; Browning, 1971; Kohlenberg, 1970), auditory hallucinations (Turner, Hersen, & Bellack, 1977; Alford & Turner, 1976; Bucher & Fabricatore, 1970), destruction (e.g., Foxx, McMorrow, Bittle, & Bechtel, 1986; Bucher & King, 1971; Birnbrauer, 1968) screaming (Lebow, Gelfand, & Dobson, 1970; Hamilton & Standahl, 1969), obsessive behaviors (Anderson & Alpert, 1974); wrong answers (Kircher, Pear, & Martin, 1971; Birnbrauer, 1968), self-

induced seizures (Wright, 1973), stereotypic rocking (Baumeister & Forehand, 1972), and noncompliance with a direction to approach (Lovaas, Schaeffer, & Simmons, 1965).

With respect to the use of CSS to treat aggression, we found nine original published studies but none in the last 13 years. The topographies treated included aggressive biting (Foxx, Zukotynski, & Williams, 1994), hair-pulling and aggressive/destructive episodes (Foxx, Bittle, & Faw, 1989), pinching, kicking, hitting, and hair-pulling (Foxx, McMorrow, Bittle & Bechtel, 1986), assaults toward others (Ball, Sibbach, Jones, Steele, & Frazier, 1975), biting, kicking, and choking (Brandsma & Stein, 1973), physically striking another person, (Browning, 1971), hitting, kicking, biting, spitting, and verbal threats to aggress (Ludwig, Marx, Hill, & Browning, 1969), biting, (Birnbrauer, 1968) and aggression toward a brother (Risley 1968).

The CSS literature has limitations. First, most papers report CSS use with only one or relatively few individuals. The largest study was by Duker and Seys (1996) who reported CSS use with 12 participants.

Second, a variety of shock delivery systems with varying shock intensity and durations have been used. For example, within the past 21 years, shock delivery systems have included the HSP 3012 (Duker & Seys, 1996), Therapeutic Shock Device (TSD) (Mudford, Boundy & Murray, 1995), Hot Shot Power Mite (Williams, Kirkpatrick-Sanchez, & Iwata, 1993), Self-injurious Behavior Inhibiting System (SIBIS) (Linscheid, Iwata, Ricketts, Williams, & Griffen, 1990), and Tritronics A1-70 (Foxx, McMorrow, Bittle, & Bechtel, 1986). The differing devices and often incomplete descriptions of their parameters make it difficult to compare the effect of CSS treatment across studies or individuals.

Third, most CSS studies have been with participants who functioned at a relatively low cognitive level and who had diagnoses such as severe mental retardation (MR) and related disabilities. Few studies have involved participants with normal or near-normal cognitive levels who had diagnoses such as conduct disorder, bipolar disorder, oppositional defiant disorder, and impulse control disorder.

In this paper we report data and procedures that address these issues. We treated aggression in 60 individuals with widely differing levels of cognitive functioning for periods of up to three years, using positive behavioral procedures supplemented with CSS. We report the immediate effects of the introduction of CSS on behavior frequency, the overall reductive effect of CSS, and its effect on ongoing accelerations or decelerations. We compare the reductive effect of CSS with the reductive effect of positive behavior support in treating aggression. We describe the differential effect of CSS treatment on participants with differing levels of cognitive functioning. And we describe the effect of CSS treatment of aggression on the need for psychotropic medication, on the need for emergency takedown restraint, and on aggression-caused staff injuries.

METHOD

Participants

A total of 60 (41 male and 19 female) residents, who were enrolled at the Judge Rotenberg Center (JRC) in Canton, MA participated in the study. The median age was 18 (range 9-36). Prior to enrolling in JRC, the participants had attended a median of 4 (range 0-42) special needs day, residential, psychiatric or correctional programs and had been prescribed, at various points in their history, a median of 6 (range 1-21) different psychotropic medications. Although treatment histories varied, all participants in this study had been rejected by, unsuccessfully treated in, or expelled from other settings that had used a combination of positive-only behavioral interventions and psychotropic medications. Demographic information for the participants is presented in Table 1. Note that the total of Other

Diagnoses (81) exceeds the number of participants (60) because many participants had multiple diagnoses. Forty-seven percent did not have an MR diagnosis.

Table 1
Participant demographic information including frequency count of all assigned diagnoses (N=60)

		Number	%
Gender			
male		41	68
female		19	32
	Total	**60**	**100**
Age			
<10		1	1.7
10-15		12	20.0
16-20		40	66.7
21-25		5	8.3
26<		2	3.3
	Total	**60**	**100**
Diagnosis re Mental Retardation Status			
No Mental Retardation		28	46.7
Mild		11	18.3
Moderate		7	11.7
Severe/Profound		14	23.3
	Total	**60**	**100**
Other Diagnoses			
Autism		16	
Mood Disorder NOS		10	
Intermittent Explosive Disorder		10	
Conduct Disorder		8	
Oppositional Defiant Disorder		8	
Bipolar Disorder		8	
Pervasive Developmental Disorder		6	
Attention Deficit Hyperactive Disorder		4	
Impulse Control Disorder		3	
Disruptive Behavior Disorder		2	
Antisocial Personality Disorder		1	
Borderline Personality Disorder		1	
Depressive Disorder NOS		1	
Mental Disorder NOS		1	
Schizophrenia		1	
Tourette's Disorder		1	
	Total	**81**	

The participants were all of the JRC residents, for whom CSS had been added to their programs at some point during the 3-year period from June 1, 2003 to May 31, 2006 and whose enrollment had not been significantly interrupted by absences. During this period a total of 65 residents met this criterion. Four were excluded because of logistical difficulties in obtaining written consent. One guardian did not consent to participate. Another 7 residents had CSS added to their programs during this period; however, their data were excluded from this study because of long absences from the program due to medical needs or other circumstances.

CSS was not considered for each participant until a variety of positive-only procedures had been tried at JRC and had been found or judged to be insufficiently effective in light of the clinical needs of each participant. The median number of weeks during which positive-only procedures alone were tried, prior to the introduction of CSS, was 38 (range 5-108). In a few cases, where the aggressive behavior was judged to be so extreme or problematic that even a single occurrence could be extremely dangerous, CSS was started shortly after the participant was admitted to JRC.

Psychotropic medication

Forty-eight of the 60 participants were receiving a median of 2 (range 1-6) psychotropic medications when they enrolled at JRC. Under the direction of a consulting psychiatrist, these medications were gradually reduced over a median of 5 (range 0-42) months. Most participants were weaned from psychotropic medication during the baseline phase. In a few cases the weaning extended into the treatment phase.

Safeguards

The following safeguards were in effect prior to the use of CSS: (a) The parent/guardian gave informed written consent to the use of CSS. (b) If the participant was of school age, CSS was placed in his or her Individual Education Plan. (c) A doctoral level clinician, with training in behavioral psychology, headed the participant's treatment team and composed a treatment plan that included the option to employ CSS. (d) A physician and, where appropriate, a neurologist and/or cardiologist certified the absence of medical contraindications to the use of CSS for each participant. (e) A psychiatrist certified the absence of psychiatric contraindications to the use of CSS for each participant who had a mental illness diagnosis. (f) An internal peer review committee reviewed the plan and deemed it appropriate. (g) A human rights committee composed of JRC parents, as well as community members unaffiliated with JRC, approved the plan. (h) A Massachusetts Probate Court judge authorized the treatment plan through a "substituted judgment" petition in an individual court hearing in which the participant was represented by his or her own court-appointed attorney. (i) The court-appointed attorney retained his or her own psychologist to provide advice concerning the proposed treatment.

Additional safeguards were in effect after the treatment plan went into effect. Reports on the participant's treatment status were submitted to the Probate Court every 3 months and the judge held a formal review each year. In all cases in which CSS was used for 3 or more years, a special committee composed of JRC staff and consultants, including two independent clinicians unaffiliated with JRC, reviewed the treatment and its results to determine if it should continue.

Setting

All participants lived in apartments or homes operated and staffed by JRC and were transported to and from JRC's day program where they received treatment, education, and vocational instruction and opportunities. During the first 4 months of the 3-year period reported here, participants attended the day program 5 days per week. During the remaining 32 months of the period, participants attended the day

program 7 days per week. The same treatment procedures were in place and carried out consistently in the school building, in the residence, on field trips, and during transportation to and from school.

The participants' programs in both day and residential settings were monitored directly by on-scene supervisors, as well as remotely by supervisors who watched live and recorded video and audio, on a sampling or continuous 24/7 basis. Video cameras and microphones were mounted in all appropriate locations of the school and residences. This equipment allowed the supervisors to monitor from a central office, in real time over the Internet, all activities in the participants' classrooms and residences.

Behavior categories and topographies

A supervising clinician, with a caseload of 15 to 20, oversaw each participant's program with the assistance of other members of the treatment team, such as the teacher, residence supervisor, and a case manager. The behavior category treated was termed "aggression," meaning any behavior that inflicted harm on other persons. Because there are an unlimited number of topographies that a participant could use to inflict harm on others, and because new topographies could emerge abruptly, each participant's clinician identified the topographies that were currently in the participant's repertoire and was authorized, in the court-approved treatment plan, to identify and add other topographies to the treatment plan as soon as they were displayed.

Examples of topographies within the aggression category included the following: hit others, bite others, kick others, throw objects at others, head butt others, choke others, and pull hair of others. The topographies treated included not only the ultimate aggressive behaviors themselves, but also antecedent behaviors, attempts and threats to execute the behavior, shaped-down (vestigial) versions that were displayed during the deceleration of the behavior, as well as initial and intermediate members of the chain that included the ultimate aggressive action.

For all participants, aggression was only one of several behavior categories that were treated with CSS at the same time. The other categories that were treated depended on the participant's treatment plan and could include health dangerous (self-injurious), destructive (e.g., breaking windows, desks, computers), noncompliant (e.g., refusal to follow a request), and major disruptive (e.g. swearing, yelling, disrobing in public, etc.), behaviors. Data for the treatment of these other behavior categories are not included in this report.

Data collection

Frequency data was collected by direct care staff 24 hours per day, 7 days per week. Each aggressive topography was tallied as it occurred, using recording sheets that were segmented by hour and that accompanied the participants in all activities. Hand counters were used to count high frequency behaviors. Aggressive behavior sometimes occurred in episodes in which several aggressive actions occurred within a short period of time. In these cases, the staff member administered one application of CSS to consequate the entire episode, but tallied each individual aggressive behavior. The total number of aggressive behaviors exhibited each day was entered in a database and displayed on daily, weekly, monthly, or yearly software charts that were updated daily and made available to clinicians, teachers, and parents through a computer network. Total CSS applications were recorded separately and totaled across all treated behaviors, but were not separated by behavior categories such as aggression.

To evaluate the effects of CSS treatment of aggression on participants of differing functioning levels we classified students by functioning level and compared the reductive effect of the treatment on the two groups. To obtain information about psychotropic medication use, emergency takedown restraints, and aggression-caused staff injuries we reviewed the participants' records as well as records of staff injuries.

Materials

CSS was administered by means of a skin-shock device called the Graduated Electronic Decelerator (GED). GEDs of two strengths were used—the GED-1 and GED-4. The GED-1 produced an average current of 15 mA RMS and an average voltage of 60 V RMS when applied to a resistor of 4 kΩ (typical skin resistance for the GED-1). The electrical stimulus was a preset, 2 s train of direct current square waves with a duty cycle of 25% and a pulse repetition frequency of 80 pulses per second. The GED-4 produced an average current of 41 mA RMS and an average voltage of 66 V RMS when applied to a resistor of 1.6 kΩ (typical skin resistance for the GED-4). The other parameters of the GED-4 were identical to those of the GED-1.

Each GED system was comprised of a remote control transmitter, a shock generator (the GED device itself), a battery and an electrode. The transmitter, a SECO-LARM (model SK-919TD2A) two-channel RF transmitter, operated at 315 MHz and transmitted a uniquely coded signal to the receiver which was worn by the participant. The transmitter was housed in a lexan box (104 mm x 76 mm x 38mm) with the participant's name and photo on the outside.

The shock generator consisted of a receiver (SECO-LARM model SK-910) set to the same code as the transmitter, a shock controller circuit board that created the shock stimulus, and a stimulation-indication beeper (Mallory piezoelectric ceramic buzzer model PLD-27A 35W). The shock generator was housed in a lexan box (140 mm x 89 mm x 38 mm) and the unit weighed 269 g.

A 12 V rechargeable nickel metal hydride battery pack (Panasonic P/N HHR-AAB 2000 mAh) provided power to the shock generator and was housed in a lexan box with the same dimensions as those of the shock generator. The battery unit weighed 397 g. The battery was attached by Velcro to the shock generator and connected to it electrically by a short cable (Hirose Electric Co., Ltd., Part # H0063-ND). The battery and shock generator were both carried in a back pack or fanny pack worn by the participant. A cable (Hirose Electric Co., Ltd., Part # H0063-ND) connected the shock generator to the electrode. Each electrode was attached to one of several pre-approved locations, typically the arms, legs, or torso. The electrode and connecting cable were hidden by the participant's clothing.

The electrodes employed during the 3-year period were of two types: (1) a "concentric" electrode which consisted of a stainless steel button (diameter 9.5 mm, thickness 3.25 mm) surrounded by a stainless steel ring (outer diameter 21.5 mm, inner diameter 16.5 mm, thickness 3.25 mm) with 2.35 mm between the outer edge of the button and the inner edge of the ring; or (2) a "distanced" electrode consisted of two stainless steel buttons (diameter 9.5 mm, thickness 3.25mm) mounted up to 15.24 cm apart on flexible nonconductive material. During the 3-year period covered in this report, the vast majority of the participants wore distanced electrodes.

Each participant wore from one to five GED sets (each consisting of battery, shock generator, and associated electrode), depending on the decision of the participant's clinician as to the following: (a) whether it was necessary to consequate attempts by the participant to remove the equipment or interfere with the application; and/or (2) whether the participant would otherwise be able to defeat much of the effect of the CSS by tensing the muscles in the affected area prior to the application. Each remote control unit sent a signal to only one particular GED shock generator and that shock generator was connected to one electrode on the participant's body. When a participant wore more than one GED set, the therapist possessed a separate remote control for each set. In these cases, on any given application the participant did not know which electrode would deliver the skin-shock (i.e., which remote control device the staff member would employ). Electrodes were rotated to different skin locations at the end of each hour and after a skin-shock was applied.

Procedure

There were two phases, baseline followed by treatment.

Baseline (Positive Programming).

Upon admission, functional assessments were completed for each participant. These suggested functions that were varied among individuals and were sometimes multiple and unknown.

To take account of the various possible functions, all environments and staff procedures were designed so that regardless of what event or events might function as a reinforcer on any given instance of the behavior, inadvertent or deliberate reinforcement of undesired behaviors would be avoided or minimized. In particular, systems were set up, and staff were trained, to insure that (a) any inadvertent reinforcement from positive or negative attention would be minimized or avoided whenever problem behaviors occurred; (b) any escape from demands that inevitably had to occur after a problem behavior was displayed would be minimized or avoided; and (c) desired tangible items or activities would never be arranged or allowed as the immediate consequence of a problem behavior. All participants were taught how to gain attention, escape from work, and obtain desired items or activities through appropriate and easily executed behaviors.

The participant's clinician reviewed daily behavior frequencies and frequency trends over time. As the clinicians prescribed and adjusted combinations of antecedent, reinforcement, extinction, response cost, and other procedures, they were able to see the effects of these changes in the charted data and make compensating adjustments when required. This amounted to an ongoing, *in vivo* functional analysis.

During the baseline phase, a variety of positive programming procedures were employed to decrease the aggressive behavior and to teach alternative desired behaviors. Each participant had DRO/DRA contracts in which, if the participant avoided displaying the problem behaviors during a certain period of time or activity, and also displayed desired behaviors in their place, reinforcers would be earned. Typically, each participant had multiple overlapping contracts covering different stimulus situations and periods (transport, overnight, less-than-a-day length, multiple-day length, etc.). The length of the contracts was gradually lengthened whenever possible. When a participant passed (i.e. met the conditions of) a contract, he/she was given points, tokens, or immediate access to desired items or activities. By passing a sufficient number of contracts, students could advance to higher level classrooms and residences with more privileges, gain more independence, and/or earn a part-time or full-time paid job inside or outside JRC.

Participants also received points, tokens, and other reinforcers on an intermittent basis throughout the day (essentially on an intermittent, momentary DRA schedule) provided they were "on contract" and engaging in appropriate behavior at the time the reinforcer was delivered.

Points, tokens, and direct access to reinforcers could also be earned by learning new academic, self-care and vocational skills and by responding appropriately to programmed stimuli, sometimes designed to represent stimuli that triggered problem behaviors, presented at various points during the day.

Points and tokens could be turned in for access to one or more of the following: money (participants could earn as much as $30 per week); field trips; the Reward Corner of the classroom; the Big Reward Store, which was an arcade-type room with pool table, pinball machines, video games etc.; the Internet; the Contract Store, which was a retail "store" with a variety of items for sale; items in the Classroom Reward Box; weekly field day activity, including barbecue and other desired activities; extra phone calls to parents and friends; opportunity to watch TV, play video games, or listen to music using entertainment consoles in the participants' bedrooms and living rooms; etc.

Other procedures included functional communication training, training in social skills, self-instruction in academic skills using personal computers as teaching machines (Skinner, 1958), and

vocational training. Higher functioning participants were given behavioral counseling, self-management training, a course in behavioral psychology presenting a simplified version of the concepts presented in Skinner's "Science and Human Behavior" (Skinner, 1953), and weekly behavioral chart shares with other participants/students.

Every item or activity that the participants might enjoy was used as a contingent reward to encourage desired behavior. Undesired behavior resulted in money or point fines and/or a loss of privileges previously earned. Extremely dangerous behaviors were contained using emergency restraint and protective equipment. In some cases, mechanical restraint was employed to insure the participant's safety.

Treatment (Added CSS).

In this phase, all of the positive procedures employed during the baseline phase continued to be used and adjusted by the clinicians; however, all topographies listed under the aggression category were now also "consequated" with a single GED application as soon after they occurred as possible. The normal procedure for administering a GED application required the staff member to enlist a second staff member to insure that (a) the person about to administer the GED had selected the correct recording sheet for the participant, (b) the topography that had just occurred (or which was still occurring) had been pre-identified on that recording sheet as being a treatment target, (c) the consequence (GED) was the correct consequence for that topography, and (d) the person administering had selected the correct remote control for the participant. These requirements introduced a slight delay in the administration of the consequence; however, the gains in insuring proper execution of the procedure were judged to be worth the slight delay involved.

Some participants wore more than one GED, and up to a maximum of five GEDs, if it was necessary to consequate attempts by the participant to remove the equipment or interfere with the application, and/or where the participant would otherwise defeat much of the effect of the CSS by tensing the muscles in the affected area prior to the application. Electrodes were rotated to different skin locations at the end of each hour and after a skin-shock was applied.

In certain cases, when equipment failure or other factors prevented the administration of the skin-shock, a verbal reprimand was substituted.

During the treatment phase, each time the student displayed an aggressive behavior, the staff member who administered the GED recorded the apparently-triggering stimulus as well as other setting information on the participant's daily recording sheet. This information was used by the clinician in his or her ongoing *in vivo* functional analysis of the aggressive behavior.

Although a detailed analysis of the gradual removal (fading) of the GED device was beyond the scope of this study, fading was accomplished with many of the participants. As their behaviors improved, the requirement that the GED device be worn was gradually diminished. If participants had been wearing more than one GED, the number was gradually reduced to just one. At that point, and in cases where the participant had always been using only one device, the number of hours each day during which the device was worn was gradually reduced to zero

All 60 participants were included in the Treatment phase. A total of 52 were started on CSS using the GED-1, and 8 were started using the GED-4. The decision as to which to start with was made by the clinician, and depended on factors such as the seriousness and severity of the problem behavior, the participant's previous history, and the need to maximize the likelihood of rapid and effective treatment.

In two cases, the GED-1 was employed first and the participant was later switched to the GED-4 either because the GED-1 was judged to be insufficiently effective in treating the aggression, or because it

was insufficiently effective in treating one or more of the other behavior categories that were being treated concurrently.

RESULTS

Chart display

Individual charts showing weekly totals for the participants' aggressive behaviors are presented in Figure 1. There is one chart for each participant and each participant is identified as Participant 1, Participant 2, etc. The charts are multiply/divide charts in which a relative change (e.g., a doubling, tripling, or halving) occupies a constant up-down distance anywhere on the chart. Each vertical line represents 1 week and heavy vertical lines represent every 5th week. A dashed vertical phase line indicates the week during which the participant's treatment program was supplemented with the GED-1 or GED-4. These charts are very similar, but not identical[1], to the weekly version of the Standard Celeration Chart (Pennypacker, Guiterrez and Lindsley, 2003) that is employed in Precision Teaching (Lindsley, 1990).

The data point for each "CSS introduction-week"—i.e., the week within which the GED procedure was introduced—has been omitted because the total for that week, which was based on one or more days from both the baseline and treatment phases, belonged in neither phase. The data for those weeks are provided in the Appendix. Similarly, in the two cases (Participants 29 and 31) in which a participant was changed from the GED-1 to the GED-4 during the treatment phase, the data point for the week during which the change was made has been omitted because the total for that week, which was based on one or more GED-1 days as well as one or more GED-4 days, belonged in neither condition. The data for those weeks also, are provided in the Appendix.

The charts are arranged vertically in a single column according to the date on which the GED was added to the participant's program. As a result, the charts are displayed in what amounts to a multiple-baseline-across-participants display with the intervention line (that shows the introduction of the GED) jogging to the right after each chart to show the passage of time before the next participant started on the GED.

Casual inspection of these charts shows that the supplemental use of the GED was effective in decelerating aggression in almost every single case. This is particularly evident when one takes into account the fact that on these charts (when displayed at 100% size on a computer screen) a vertical distance of approximately 6.35 mm (1/4 in) upwards or downwards, represents a doubling or halving, respectively, of the frequency.

For some participants gradual removal or fading of the GED occurred. As of December 1, 2007, 23 of the 60 participants (38%) had been able to dispense totally with wearing any GED device. Eight of these 23 had left JRC after being completely faded from the GED and moved on to less restrictive settings such as other residential schools, day programs, regular school settings, or their own home. Fifteen others were still enrolled at JRC and had various forms of partial independence in the school and in their residence. Three of the 15 had paid in-school jobs. Because many of the participants were still undergoing active treatment at the time of this report, further removals and fading that occurred after the end of the 3-year period covered in this report are not included.

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[1] On the charts of Figure 1, a data series that doubles *every 5 weeks* produces a slope of 34 degrees. On the weekly version of the Standard Celeration Charts, a doubling *every month* produces the same slope.

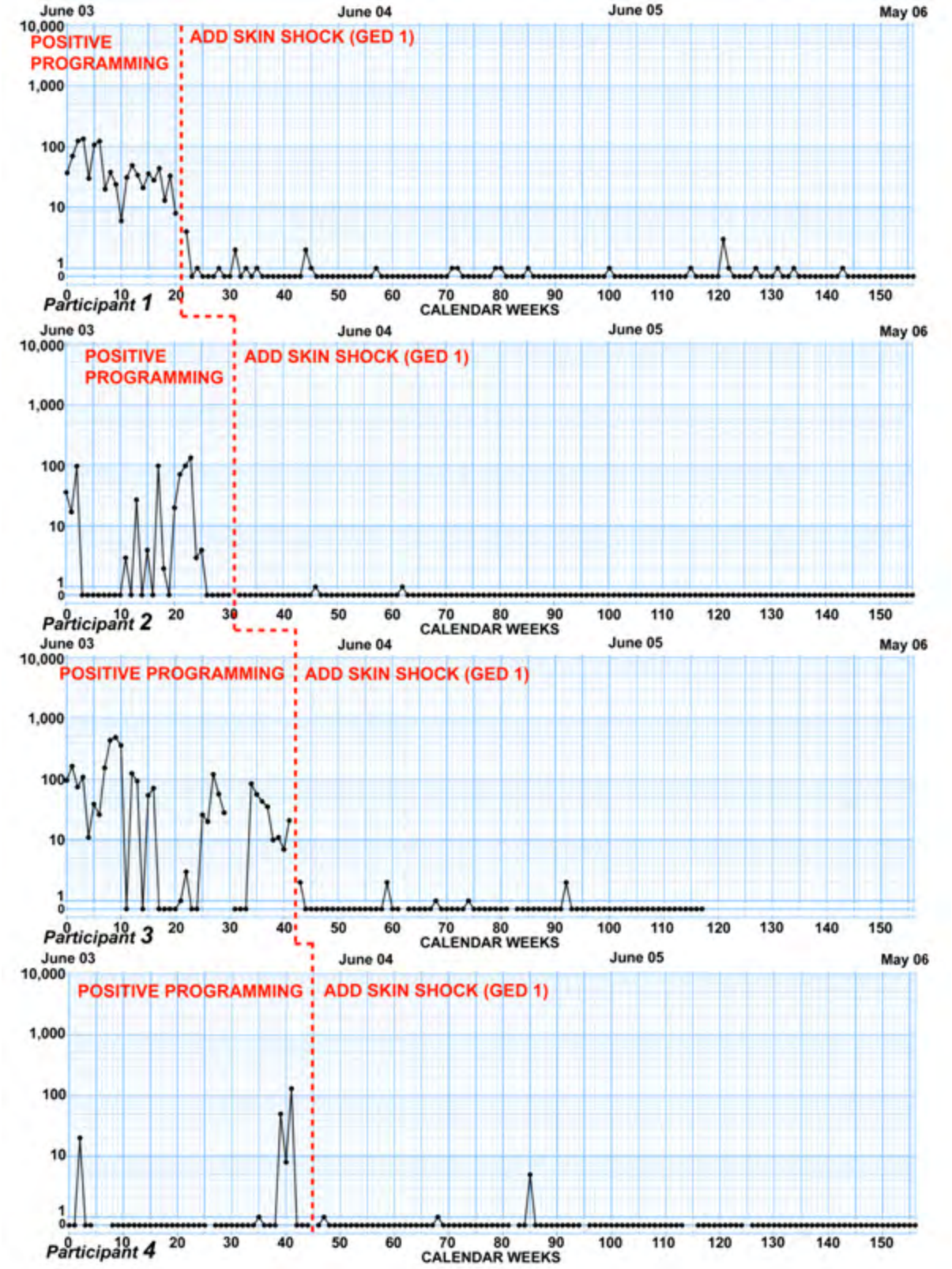
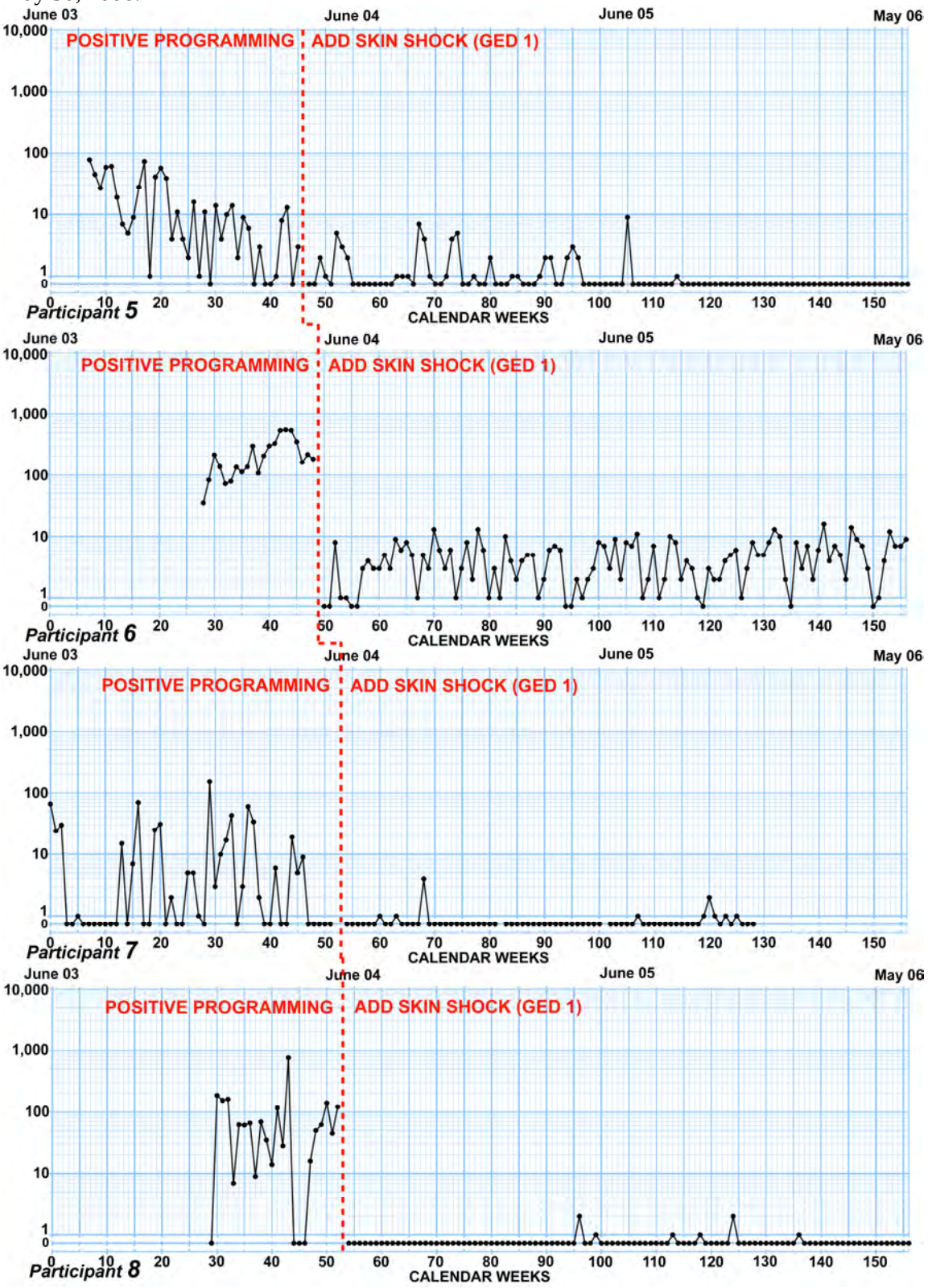


Figure 1. The weekly frequency of aggressive behaviors for each participant between June 1st, 2003 and May 30, 2006.



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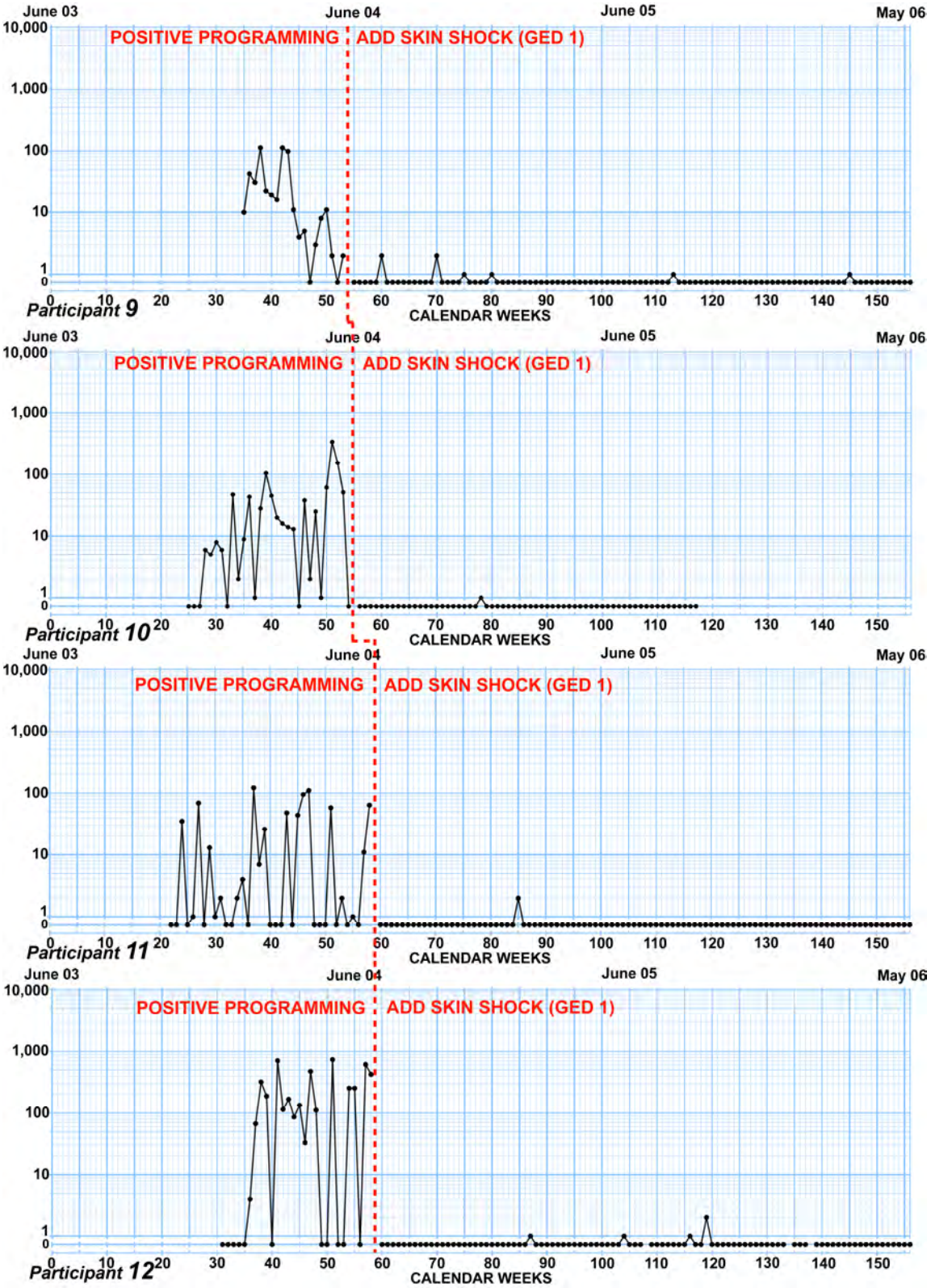

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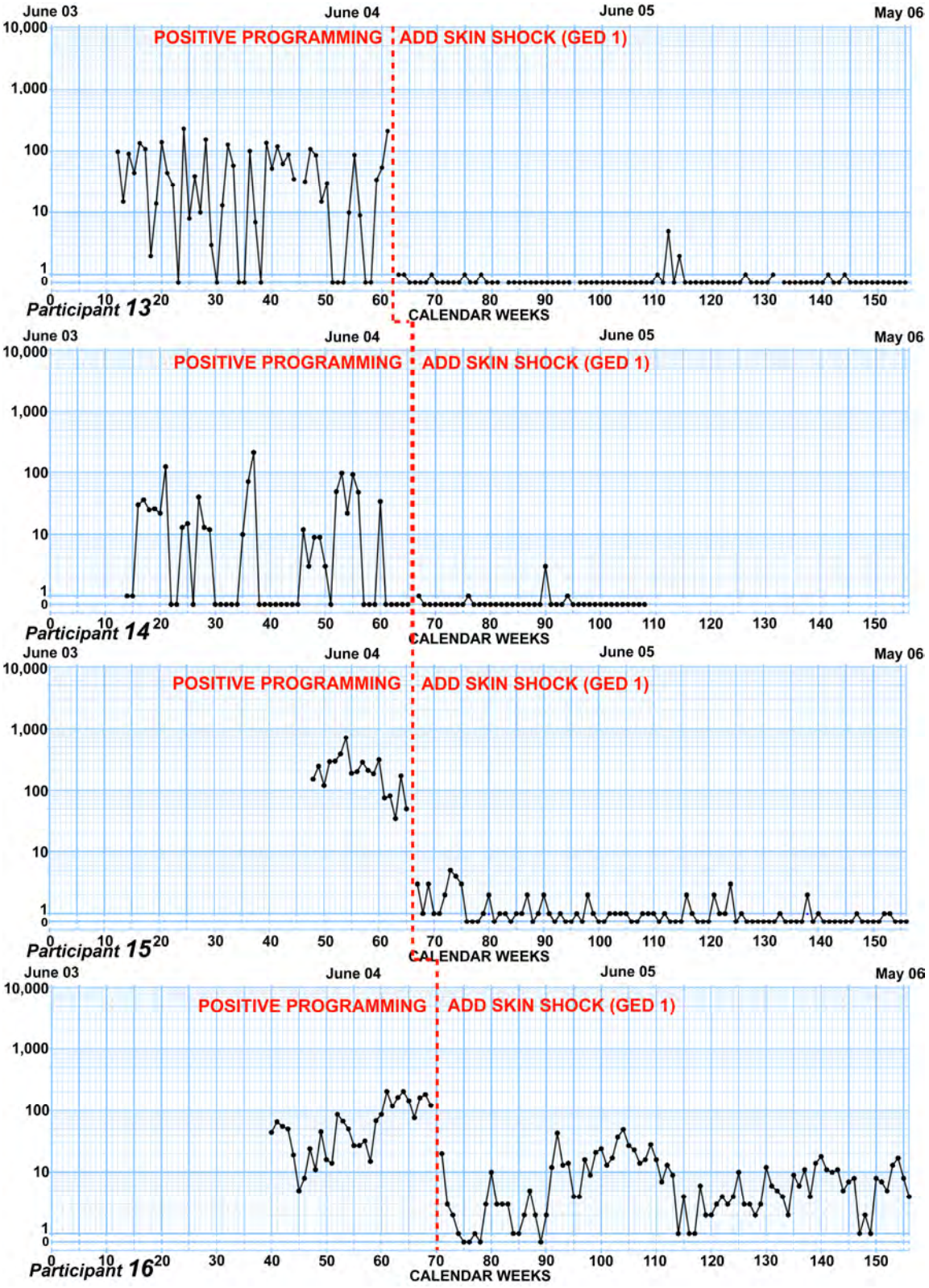

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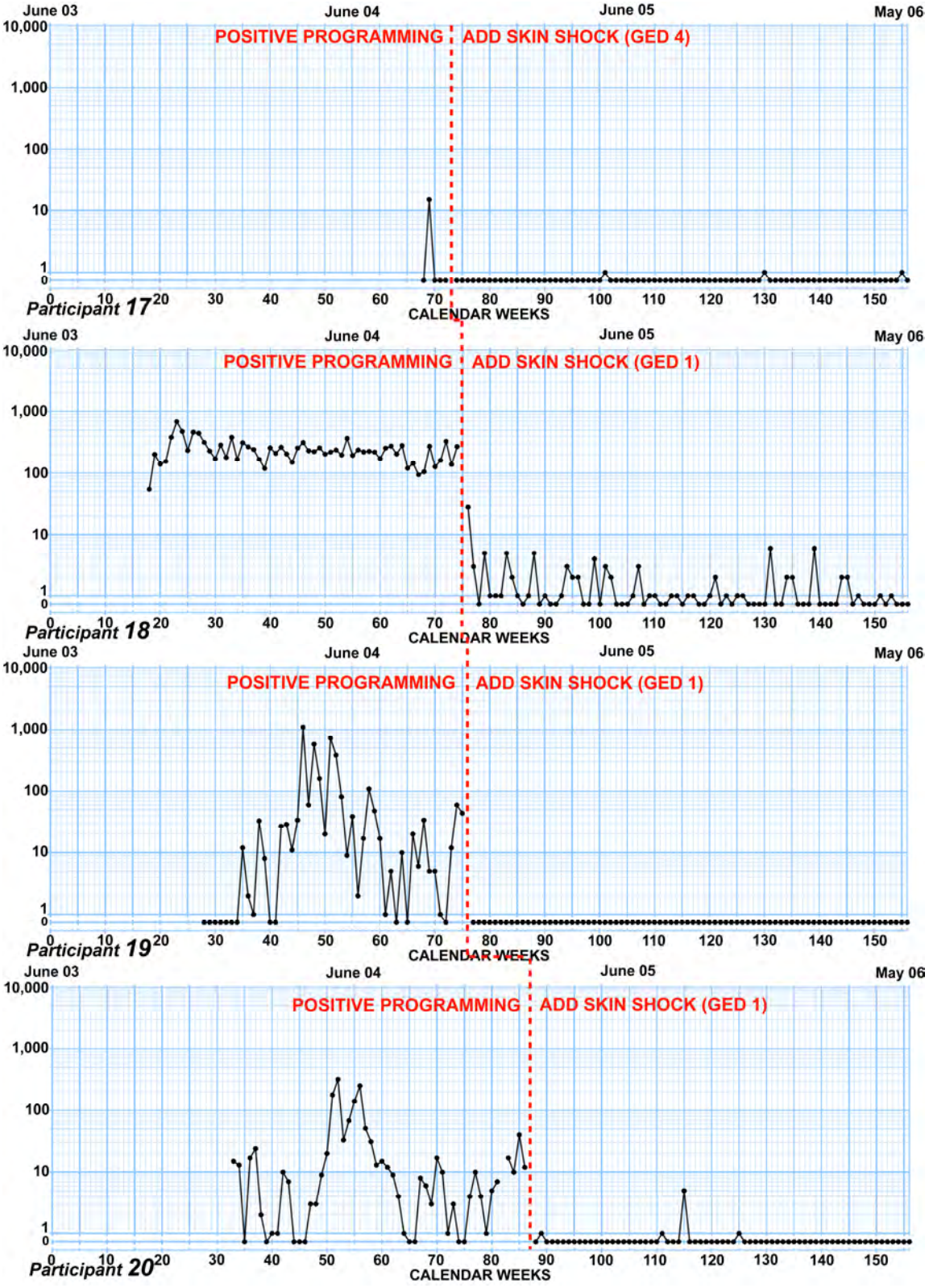

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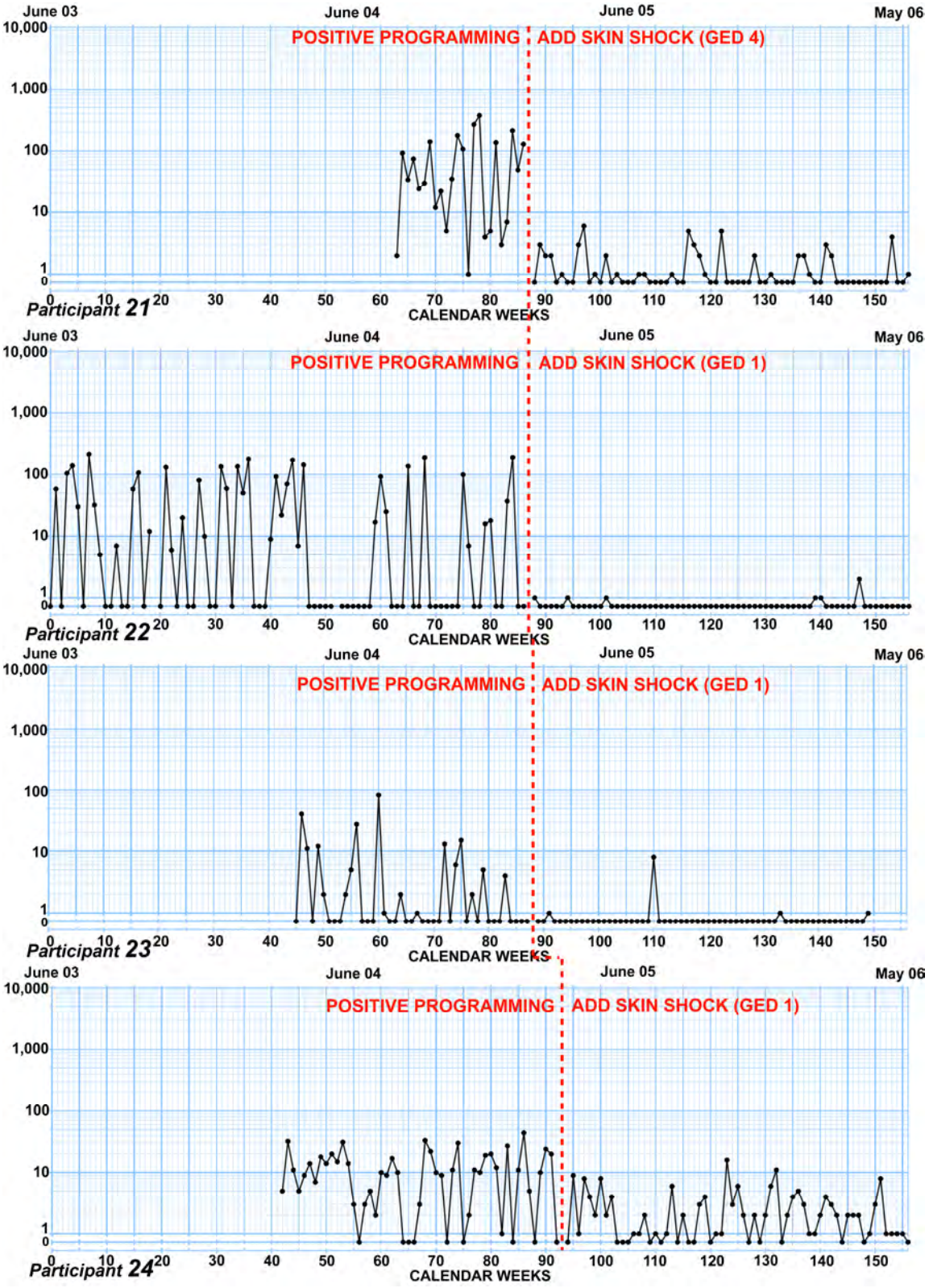

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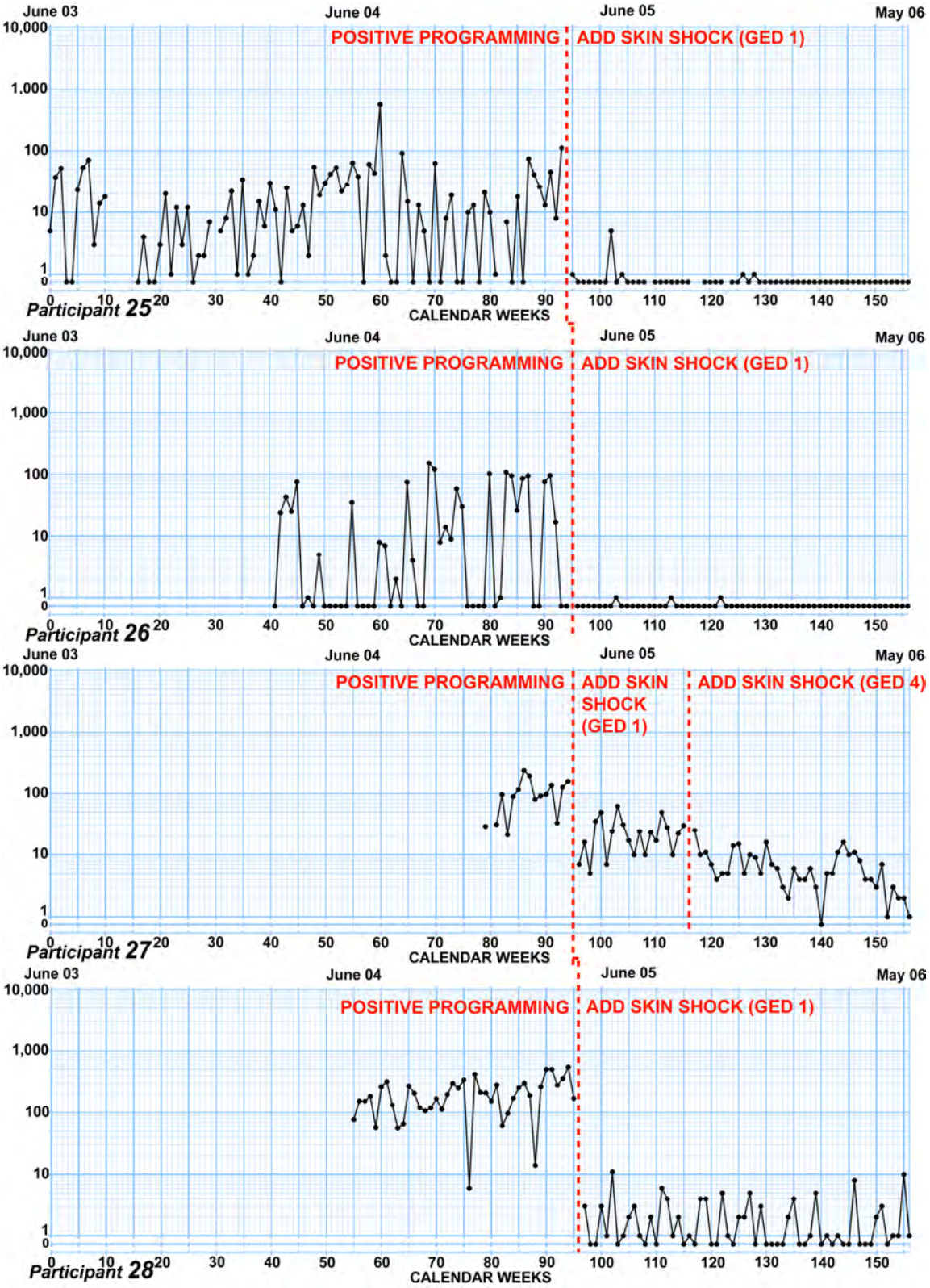

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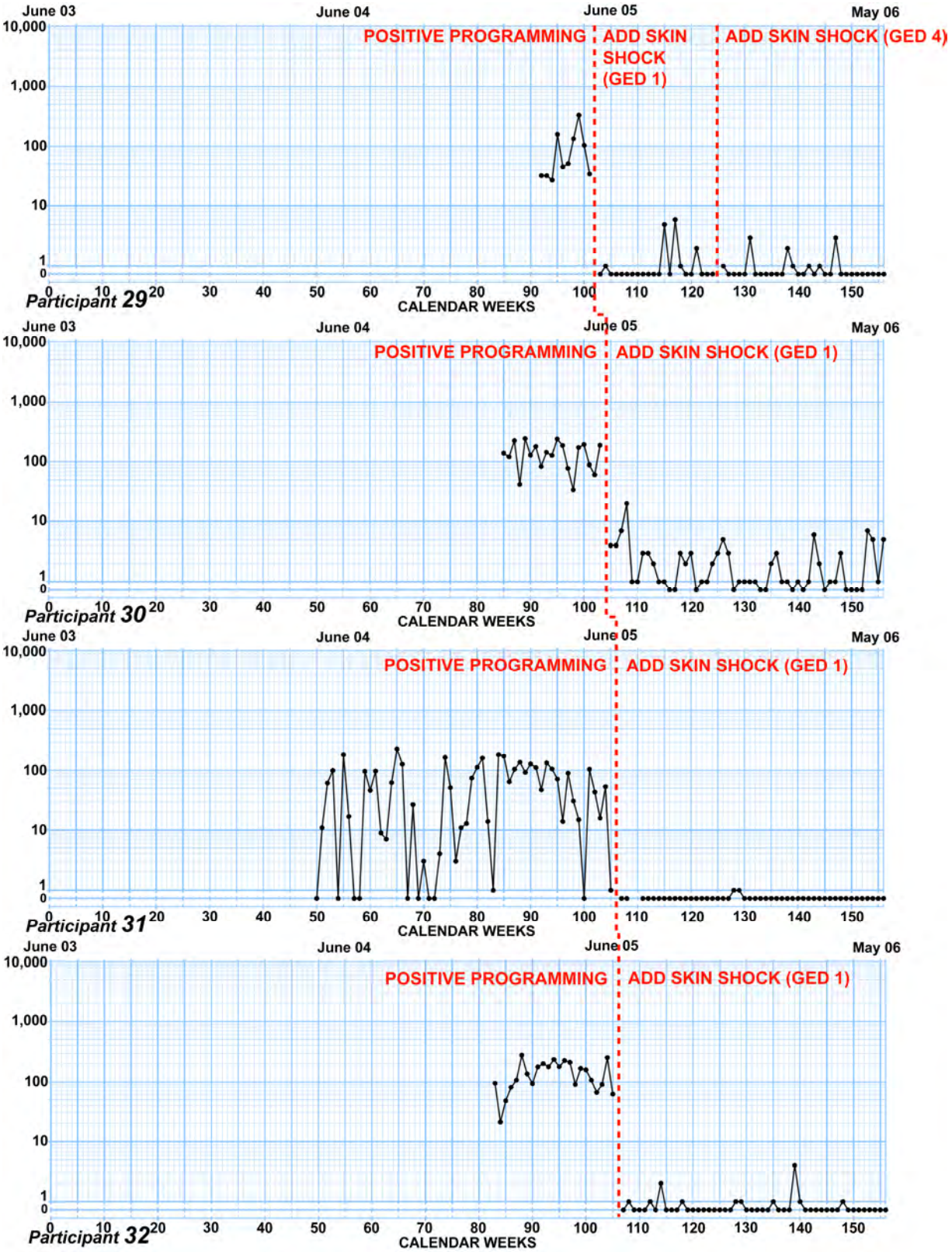

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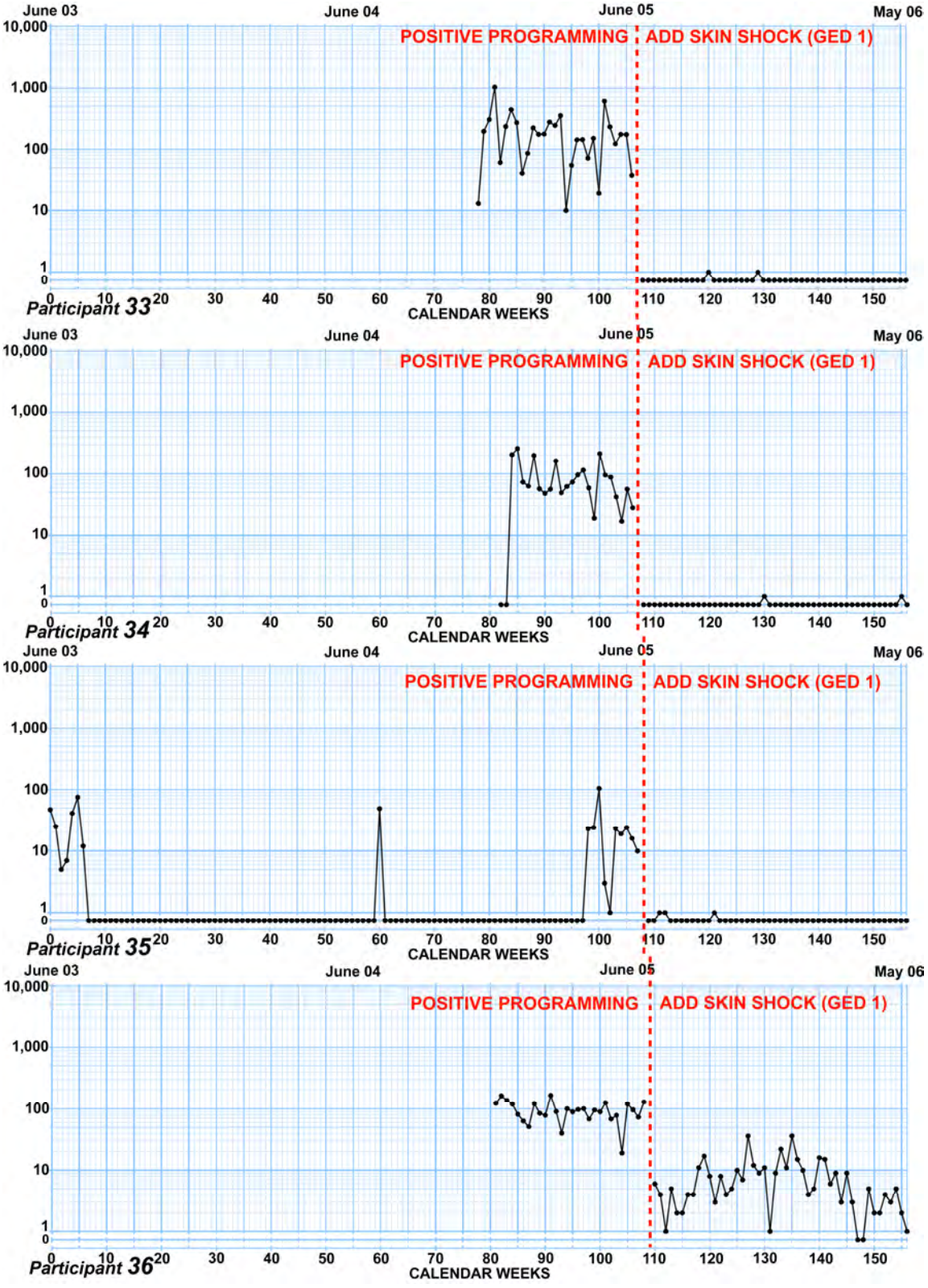

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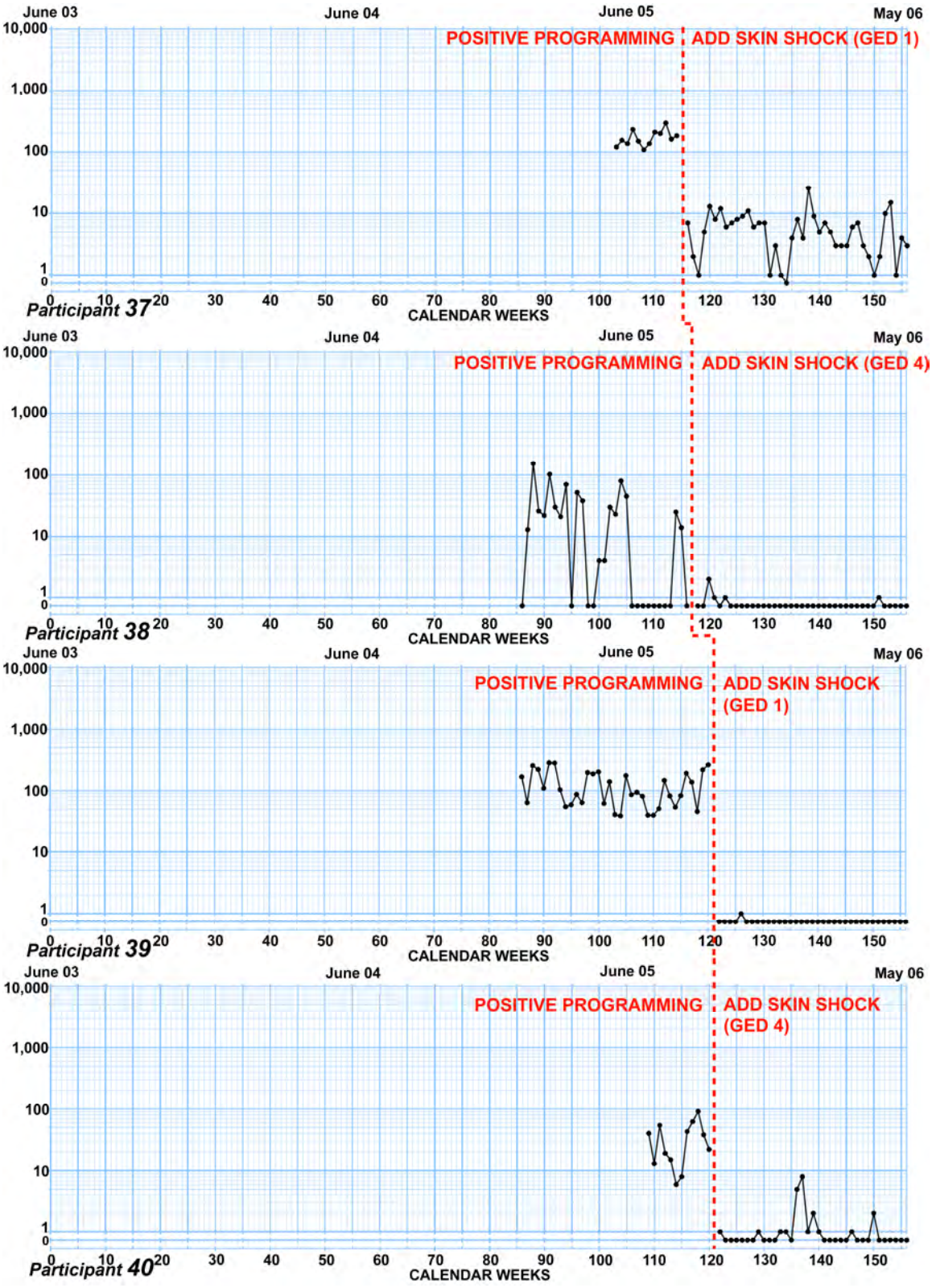

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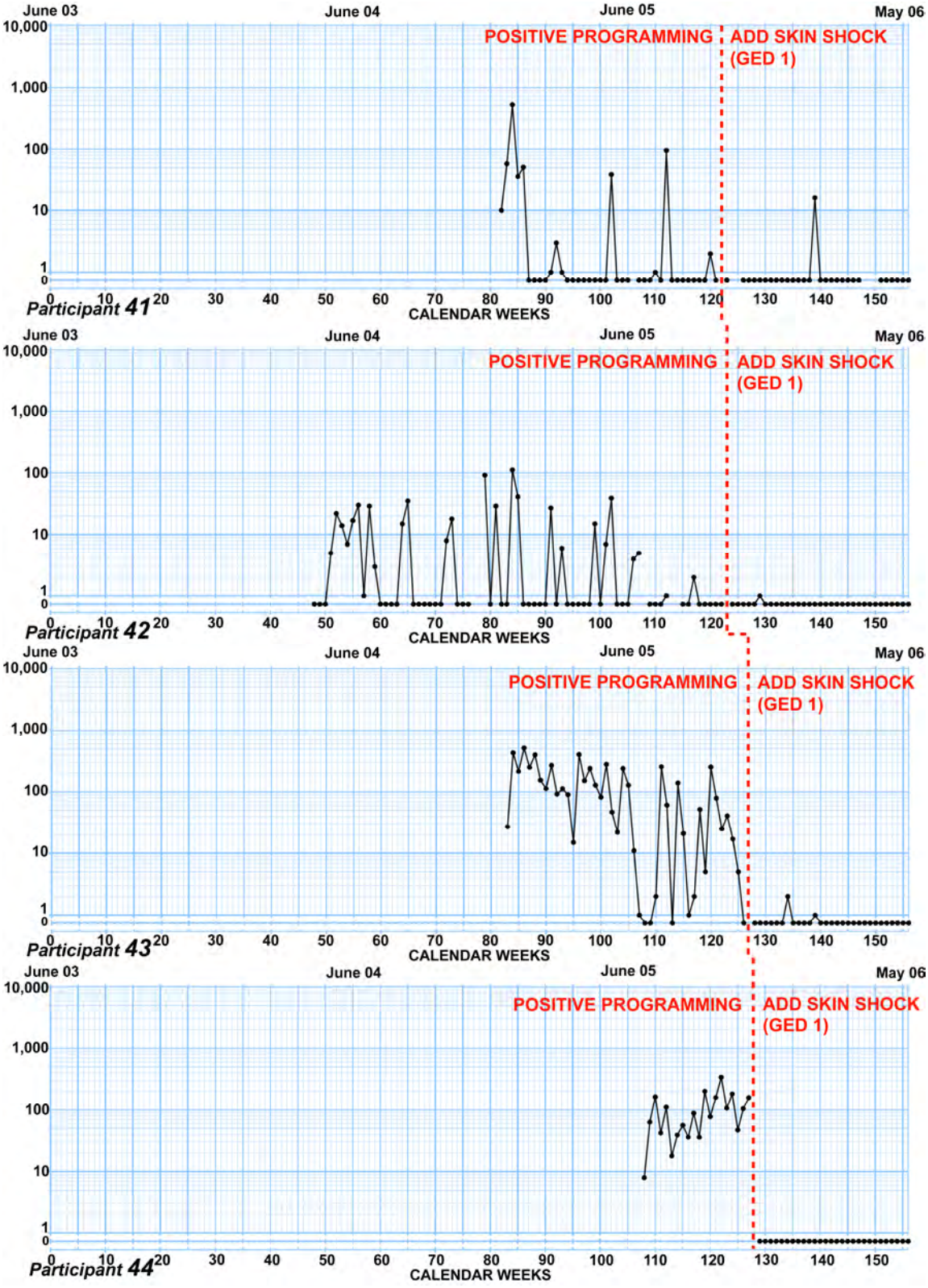

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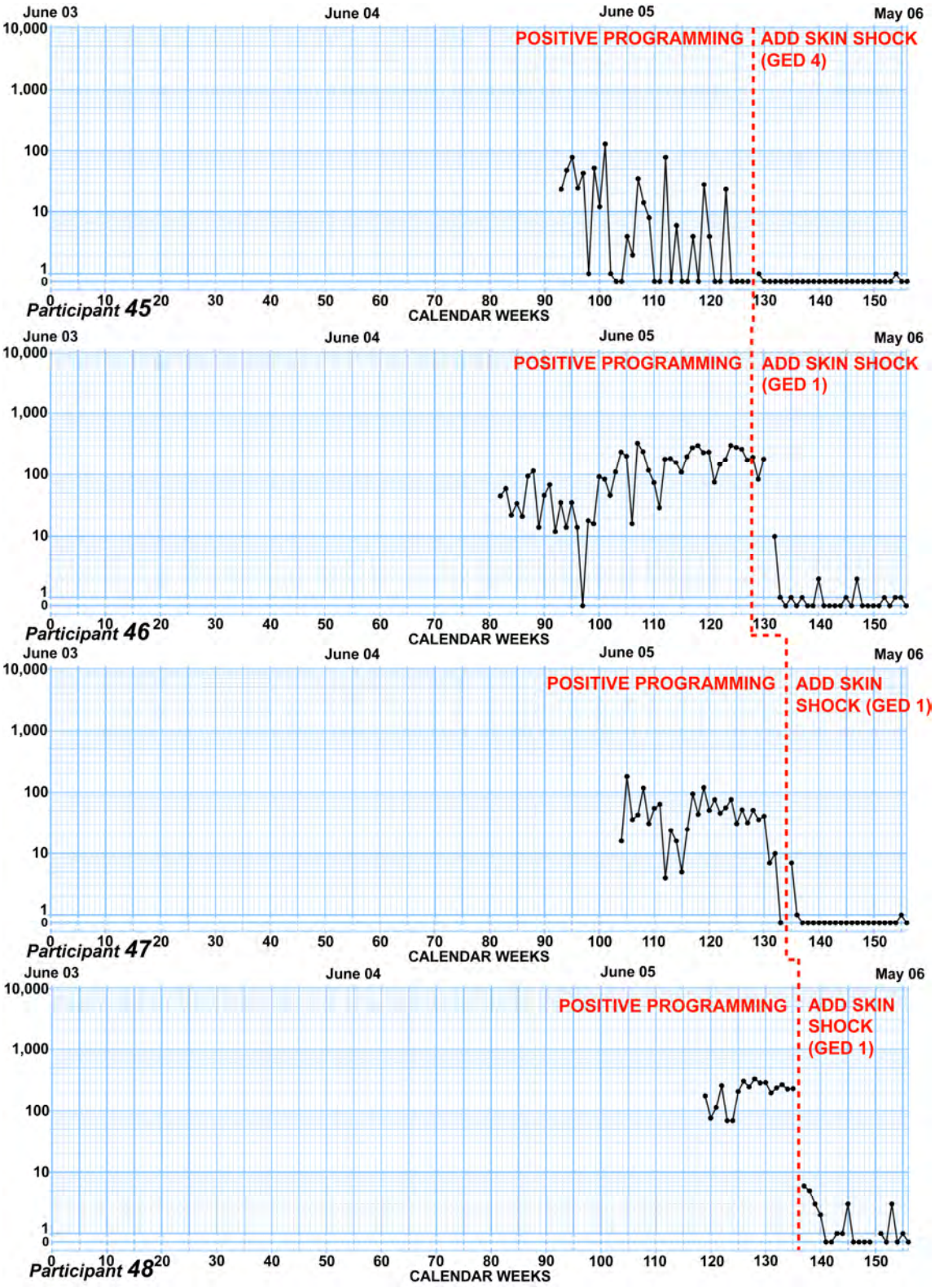

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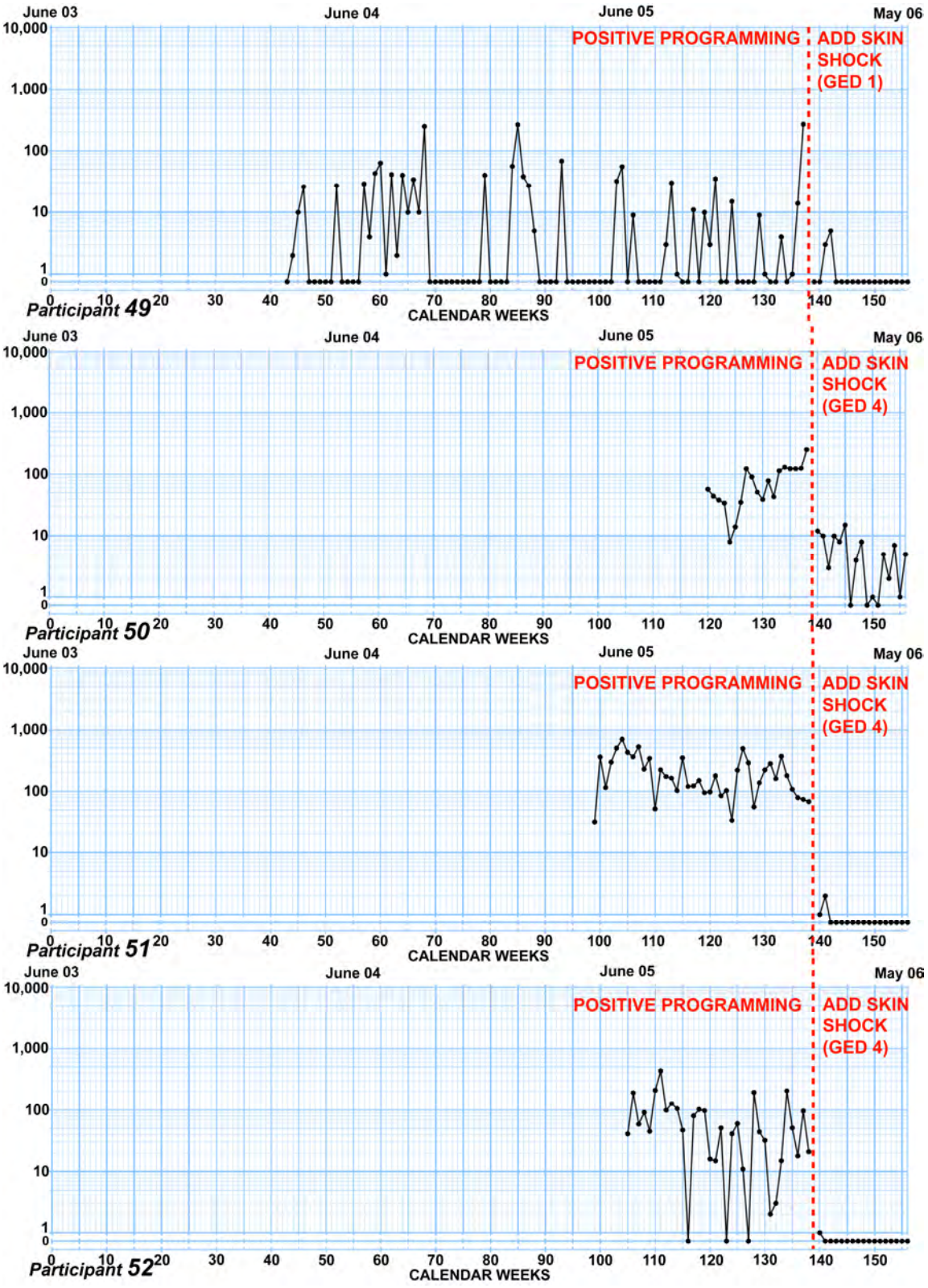

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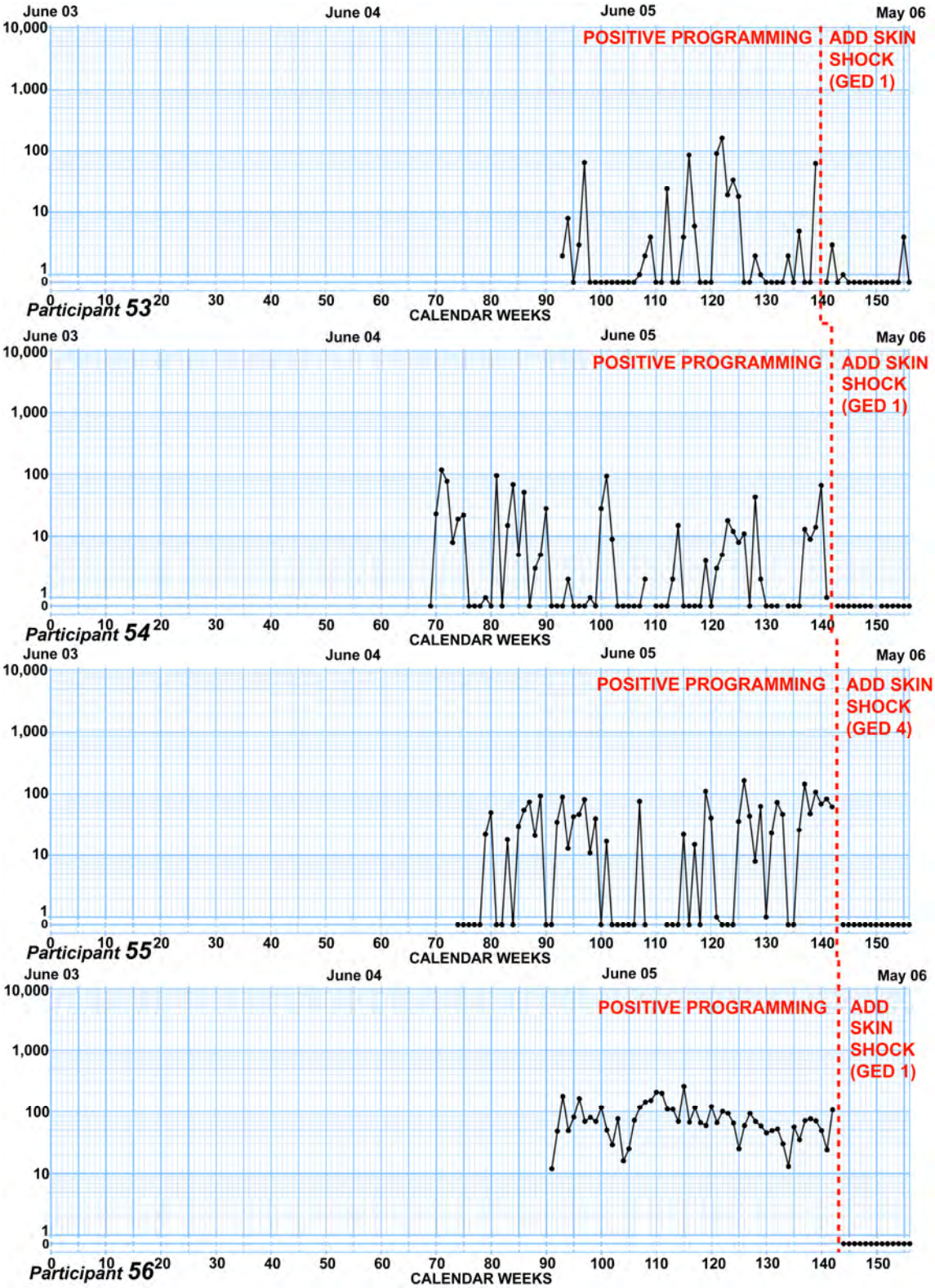

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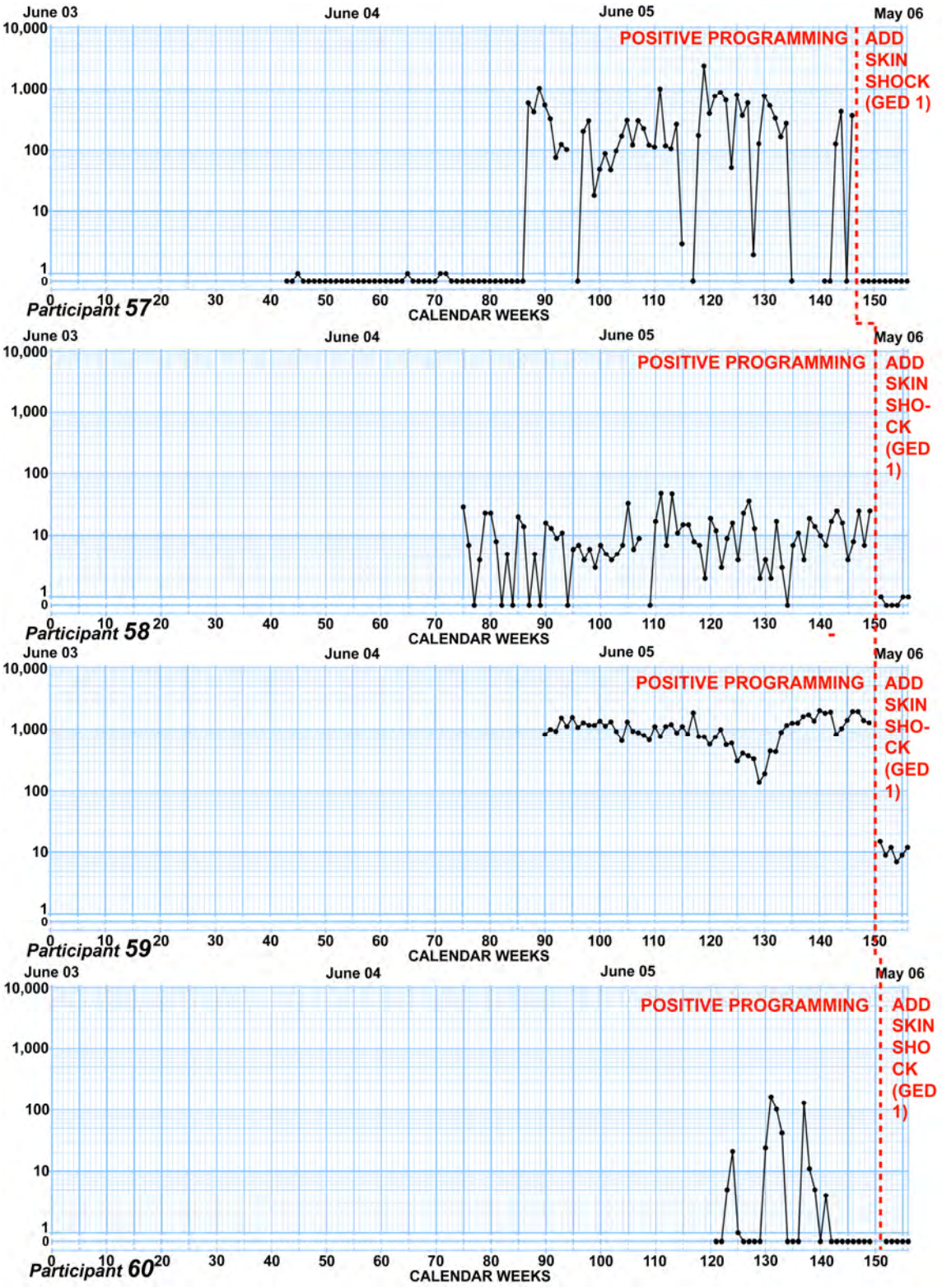

Figure 1(continued).

Trends during baseline

Table 2 summarizes the trends seen during the baseline (positive programming) phase. In 40 participants (68% of the 59 cases where there was sufficient information to characterize the trend), the frequency was either increasing (accelerating) or flat when CSS was introduced. In the remaining 19 cases, even though the behavior was decreasing in frequency (decelerating), CSS was introduced because the behavior was too dangerous to be allowed to occur at the frequency it was showing.

Table 2

Trends of aggressive behavior during baseline

Description	Total	Participant numbers
Acceleration	23	2, 6, 8, 10, 11, 16, 19, 25, 26-29, 33, 37, 40, 44, 46, 48, 50, 55, 57-59
Flat	17	4, 7, 13, 14, 18, 20, 22-24, 34-36, 39, 42, 47, 49, 54
Deceleration	19	1, 3, 5, 9, 12, 15, 21, 30-32, 38, 41, 43, 45, 51-53, 56, 60
Insufficient Information	1	17

Decelerative effect of CSS on aggressive behaviors

To analyze CSS's decelerative effect, we examined: (1) the initial change in frequency associated with the introduction of CSS; (2) the overall chart patterns found during the treatment phase; (3) the overall decelerative effect seen when all baseline data is compared with all treatment data; and (4) the changes in trends from baseline to treatment.

Initial effect on frequency

In almost every chart in Figure 1, the GED is shown to produce two separable effects. It causes an immediate decrease in frequency (jump down) right after it is introduced, and this is followed by some other trend over the succeeding weeks.[2] We chose to measure these immediate jump downs by plotting the trend (celeration) lines for both the baseline and treatment data, and measuring the vertical distance between the end of the baseline celeration line and the beginning of the treatment celeration line. If there was more than one trend during baseline or treatment, we used the last trend in the baseline data and the initial trend in the treatment data.

Figure 2 is an example of how this was done. The size of the jump down at the time of CSS introduction is the same up/down distance as the distance between 1 and 85 on the vertical scale of the multiply/divide chart in Figure 2. Therefore the jump would be characterized as a "÷ 85" (read "divide 85") jump down which means that the frequency divided by a factor of 85. Table 3 shows the jump down that occurred immediately after CSS introduction for each participant. It shows that median jump down was ÷27, meaning that the weekly frequency made an immediate decrease by a factor of 27.

[2]This observation was first brought to our attention by the late O.R. Lindsley, who also developed the precision teaching technology on which we have based much of our charting scheme and data analysis.

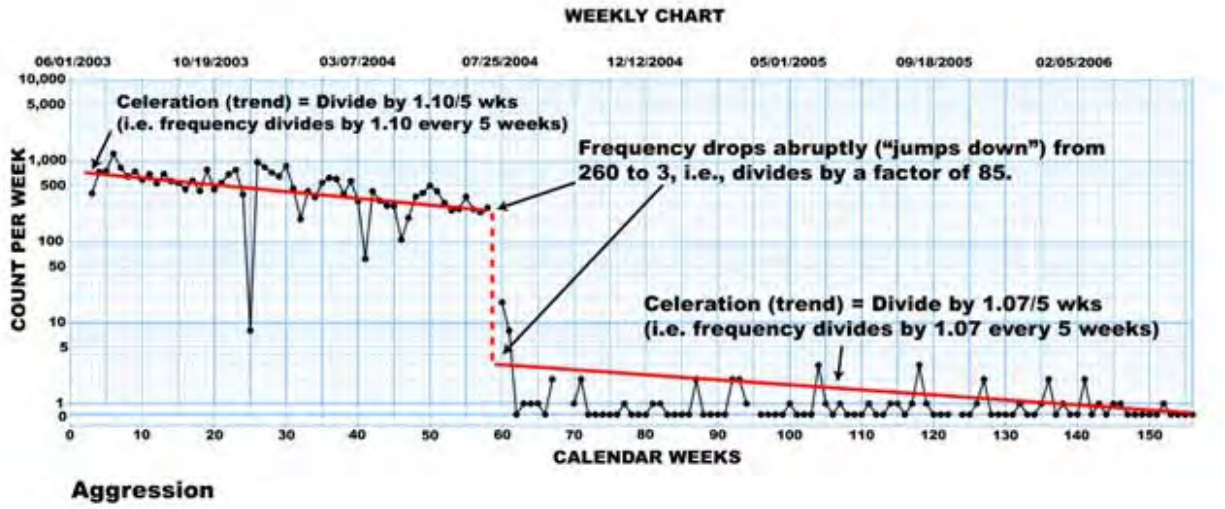

Figure 2. Sample weekly chart showing calculation of frequency jump down

Overall chart patterns during treatment phase

We classified each of the charts in Figure 1 into five categories, according to the extent of the initial jump down (i.e., whether frequency dropped to zero or not) and the trend of the data after that point. The result of this classification is shown in Table 4 which also shows the percent of cases that fall into each category.

In 48 cases (80% of the participants), aggressive behaviors were reduced immediately to a zero or near-zero level and remained at that level for whatever time remained in the 3-year period. In 5 cases (8.3%) the frequency jumped down and then showed a deceleration, but had not yet reached zero within the remainder of the 3-year period. Therefore, in 53 cases (88.3%), the behavior either jumped down to zero or near-zero immediately, or jumped down and then decelerated toward zero. In the remaining 7 cases (categories 3-5), although several different trends were seen after the initial jump down, the level of aggression during the treatment phase was substantially lower than during baseline (see next section, below) and reflected clinically meaningful improvement.

Overall decrease in frequency from baseline to treatment

For each participant, we calculated the overall mean weekly frequency of aggressive behaviors across the entire baseline phase, the overall mean weekly frequency across the entire treatment phase, and the respective standard deviations. We then calculated improvement for each participant in terms of both the percent and the factor by which the baseline mean weekly frequency had been reduced. These data are shown in Table 5.

The results are further summarized in Tables 6 and 7, and Figure 3. In Table 6, total frequency, number of weeks, standard deviation, mean per week, median per week, and range are presented for the baseline and treatment phases. In Table 7, the number of participants who achieved various percent reductions from baseline are presented. Percent reduction was calculated using the entire baseline and entire treatment means. Table 7 shows that for 30 (50%) of the participants, aggressive behaviors were reduced by 100%, and that for 57 (95%), aggressive behaviors were reduced by 92% or more.

Table 3

Frequency jump downs occurring immediately after CSS introduction (organized by magnitude)

Frequency jump down Immediately after CSS Introduction	Participant Number	Frequency jump down Immediately after CSS Introduction (continued)	Participant Number (continued)
÷800	57	÷26	8
÷500	12	÷21	17
÷150	32	÷20	4
÷120	46	÷20	34
÷110	44	÷19	2
÷110	51	÷18	21
÷100	28	÷16	19
÷100	33	÷16	38
÷90	59	÷15	35
÷85	18	÷15	36
÷80	6	÷15	50
÷80	48	÷15	53
÷60	56	÷12	39
÷56	15	÷11	3
÷52	29	÷11	25
÷50	22	÷10	49
÷49	26	÷9	1
÷45	31	÷9	58
÷44	10	÷7	20
÷42	13	÷7	42
÷40	11	÷6	7
÷40	30	÷6	45
÷40	55	÷5	54
÷36	37	÷4	24
÷30	14	÷3	41
÷30	40	÷3	43
÷30	47	÷1.6	23
÷30	60	÷1.5	5
÷29	52	÷1.5	9
÷28	16	÷1.5	27

Median = ÷27

Table 4

Summary of frequency patterns during treatment phase

	Pattern Shown by Frequency During Treatment Phase	Number of Cases	Percent of Cases	Charts
1	Jump down to zero or near-zero level; then maintenance at that level	48	80	1-4, 7-15, 17-23, 25, 26, 29, 31-35, 38-47, 49, 51-58, 60[a]
2	Jump down to non-zero level; then a deceleration	5	8.3	5, 37, 48, 50, 59
3	Jump down to non-zero level; then maintenance at that level.	3	5	24, 28, 30
4	Jumps down to non-zero level; then acceleration	1	1.7	6
5	Jumps down to non-zero level; then alternating accelerations and deceleration(s)	3	5	27, 36, 16
	Totals	60	100	

[a] Although this classification of this data series for participant 60 as a flat celeration at a zero frequency is based on only five data points, examination of the next 6 weeks of data (which are outside of the 3-year period covered in these graphs) showed that the behavior maintained at 0 during those weeks, confirming the present classification.

Table 5

Comparison of all Baseline Weeks with All Treatment Weeks

Participants	Mean Weekly Frequency During Entire Baseline Period	SD During Entire Baseline Period	Mean Weekly Frequency During Entire Treatment Period	SD During Entire Treatment Period	Percent Reduction from Baseline (means)	Reduction from Baseline (Divide by Factor)
1	48.14	39.64	0.21	0.58	100	229
2	17.03	37.41	0.02	0.13	100	852
3	68.61	111.47	0.11	0.42	100	69
4	5.1	20.72	0.07	0.49	99	73
5	17.56	22.07	0.59	1.45	97	30
6	222.77	155.7	4.67	3.61	98	48
7	12.4	26.1	0.18	0.58	99	69
8	90.79	155.13	0.09	0.35	100	1009
9	26.79	37.59	0.08	0.34	100	335
10	34.4	66.22	0.02	0.13	100	1720
11	19.32	33.72	0.02	0.2	100	966
12	167.61	227.11	0.05	0.27	100	3352
13	53.43	57.88	0.21	0.67	100	254
14	19.83	38.83	0.14	0.52	99	142

Table 5 (Continued).

Comparison of all Baseline Weeks with All Treatment Weeks

Participants	Mean Weekly Frequency During Entire Baseline Period	SD During Entire Baseline Period	Mean Weekly Frequency During Entire Treatment Period	SD During Entire Treatment Period	Percent Reduction from Baseline (means)	Reduction from Baseline (Divide by Factor)
15	220.94	156.59	0.77	1.01	100	287
16	73.1	61.63	8.74	9.36	88	8
17	3	6.71	0.04	0.19	99	75
18	239.51	106.68	1.36	3.34	99	176
19	77.08	205.5	0	0	100	77
20	26.68	60.87	0.1	0.62	100	267
21	80.63	96.71	0.84	1.39	99	96
22	33.83	56.33	0.1	0.35	100	338
23	5.42	14.53	0.18	1.04	97	30
24	11.53	10.45	2.51	3.05	78	5
25	24.59	59.68	0.14	0.66	99	176
26	25.72	39.85	0.05	0.22	100	514
27	102	64.96	12.15	12.73	88	8
28	204.27	121.44	1.78	2.45	99	115
29	94.7	94.97	0.76	1.22	99	125
30	140.58	64.59	2.17	3.12	98	65
31	60.7	61.11	0.04	0.2	100	1518
32	136.42	71.57	0.34	0.87	100	401
33	208.14	207.03	0.04	0.2	100	5204
34	85.36	69.81	0.04	0.2	100	2134
35	4.7	15.01	0.06	0.24	99	78
36	94.96	33.65	7.77	7.75	92	12
37	174.42	53.23	5.98	4.8	97	29
38	24.26	35.59	0.13	0.41	99	187
39	125.46	76.98	0.03	0.17	100	4182
40	34.25	25.58	0.69	1.6	98	47
41	20.87	83	0.55	2.74	97	38
42	8.31	18.69	0.03	0.17	100	277
43	122.75	133.78	0.1	0.41	100	1228
44	101.95	80.75	0	0	100	102
45	17.6	29.06	0.07	0.26	100	242
46	121.37	95.28	0.84	2.01	99	144
47	47.93	39.35	0.41	1.5	99	117
48	213.06	85.11	1.37	1.81	99	156
49	16.73	47.02	0.44	1.34	97	38
50	79.89	58.98	5.35	4.61	93	15
51	215.9	155.64	0.18	0.53	100	1204
52	76.56	87.73	0.06	0.24	100	1268
53	12.81	31.28	0.5	1.21	96	26
54	12.47	24.84	0	0	100	13

Table 5 (Continued).

Comparison of all Baseline Weeks with All Treatment Weeks

Participants	Mean Weekly Frequency During Entire Baseline Period	SD During Entire Baseline Period	Mean Weekly Frequency During Entire Treatment Period	SD During Entire Treatment Period	Percent Reduction from Baseline (means)	Reduction from Baseline (Divide by Factor)
55	30.33	38.12	0	0	100	30
56	81.19	49.95	0	0	100	81
57	172.94	324.67	0	0	100	173
58	11.19	10.29	0.5	0.55	96	22
59	1027.51	467.22	10.67	2.88	99	96
60	16.87	40.89	0	0	100	17
	Median = 57.07	**Median = 59.33**	**Median = 0.14**	**Median = 0.54**	**Median = 99.5**	**Median = 121**

Note: When the treatment weekly mean was equal to zero, the number 1 was substituted in order to calculate the factor by which the treatment mean was reduced. This was the case for participants 19, 44, 54, 55, 56, 57, and 60.

Table 6

Descriptive Statistics of all Participants during Baseline and treatment

	Baseline	Treatment
Total Frequency of Aggressive Behaviors	220,873	3,764
Number of Participant-Weeks	2,489	3,196
Mean per Week	88.74	1.18
Standard Deviation	203.67	3.79
Median per Week	17	0
Range	0 - 2367	0 - 62

Table 7

Percent of participants achieving certain percentage reductions

Percent Reduction	Number of Participants	Cumulative Number at or above this Percent Reduction	Cumulative Percent at or above this Percent Reduction
100	30	30	50.0
99	15	45	75.0
98	3	48	80.0
97	5	53	88.3

Table 7 (Continued).

Percent of participants achieving certain percentage reductions

Percent Reduction	Number of Participants	Cumulative Number at or above this Percent Reduction	Cumulative Percent at or above this Percent Reduction
96	2	55	91.7
95			
94			
93	1	56	93.3
92	1	57	95.0
91			
90			
88	2	59	98.3
78	1	60	100.0

The frequency distributions for the mean weekly frequency of baseline and treatment are presented in Figure 3. The baseline portion shows that of the 11 intervals, at least one student had a mean weekly frequency that fell within 10 of the intervals. By contrast, the treatment portion shows that all 60 students had a mean weekly frequency that fell within the first interval (a mean weekly frequency of 0-25).

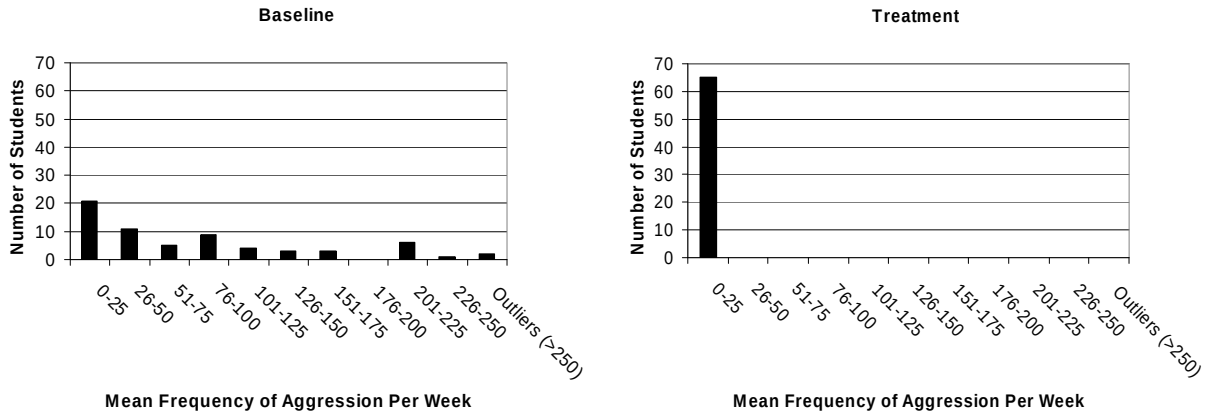

Figure 3. Frequency distribution of the weekly means.

Results of paired sample t-test and effect size

Using a paired sample *t*-test, we compared the means of aggression during baseline with the means of aggression during treatment. The difference between the means was found to be significant, $t(59)=5.01$, $p < .001$. In order to assess the magnitude of the effect, we utilized Cohen's *d* with the original standard deviation values. The effect was found to be large, $d = .91$.

Comparison of percentage reduction found in this study with those found in treatment outcome reviews

We compared the percentage reduction that we found in the present study with those reported in two treatment outcome reviews: (1) one by Cataldo (1991), who evaluated published studies (1965-1989) in which punishment was used to treat problem behaviors; and (2) one by Carr et al. (1999) who evaluated published studies (1995-1996) in which Positive Behavior Support procedures were use used to treat problem behaviors. The results, including the methods for calculating percentage reduction are shown in Table 8.

Table 8

Percentage Reductions Reported in Present Study and Two Other Treatment Outcome Reviews

Report	Type of Study	No. of Participants/Outcomes[a] Evaluated re Treatment of Aggression	Treatment Methods	Method of Calculating Percentage Reduction	Percent of Participants/Outcomes Achieving a Reduction of 90% or More
Cataldo (1991)	Treatment outcome review of 137 punishment studies, 1965-1989	4 participants	CSS employed with one or more other interventions.	Mean of all baseline data compared with mean of last 3 treatment data	60.0%
Carr et al. (1999)	Treatment outcome review of 109 Positive Behavior Support studies, 1985-1996	90 outcomes	Positive behavioral procedures only	Mean of last 3 baseline data compared with mean of last 3 treatment data	55.5%
Israel et al. (present study)	Treatment of 60 participants using multiple baseline design, 2003-6	60 participants	Positive behavioral procedures plus CSS	Mean of last 3[b] baseline weeks compared with mean of last 3 treatment weeks	100%[c]

[a] Carr (1999) evaluated "outcomes," not participants. If a single subject study used time out, then ignoring and then skin shock in three successive phases, this was counted as 3 outcomes. The Carr report does not provide information as to how many participants were involved in the 90 outcomes in which Positive Behavior Support procedures were employed to treat aggression. [b]For participants 2, 4, 7, 14, 17, 23, 42, 45, and 60 the mean of the last 3 baseline weeks was equal to zero. For those cases, the entire baseline mean was substituted in order to calculate the percent reduction. [c] Actually, when reduction percentage is calculated by comparing end-of-treatment with end-of-baseline, as was done for both the Carr et al. data and the Israel et al. data in Table 8, all 60 participants did 4% better than the normal 90% reduction standard requires. They all achieved a 94% or greater reduction from baseline.

Changes in trends (slope of acceleration or deceleration) before and after CSS introduction

Change effects that occur in data series such as those of Figure 1 can consist not only of jumps (sudden frequency changes) that are seen where trends change, but also of celeration turn downs or celeration turn ups. A celeration turn means that there is an inflection at the end of a trend at which a change in the ongoing acceleration or deceleration takes place. A celeration turn down means that one of three things takes place at the inflection point: (1) the slope of acceleration changes to a different acceleration that is less steep; (2) an acceleration changes into a deceleration; or (3) the slope of a deceleration changes to one that is even steeper. A celeration turn up means that one of these three things takes place at the inflection point: (1) the slope of acceleration changes to a steeper acceleration; (2) a deceleration changes into an acceleration; or (3) the slope of a deceleration changes to one that is less steep.

For 49 of the participants there was no opportunity to examine the celeration turns because their charts show a jump down to zero or near-zero frequencies immediately after CSS introduction. Of the remaining 11, Table 9 describes each participant's treatment data by the jumps and turns that occur. Each major change effect is labeled as to week number, and is characterized by its jump (a "jump up," "jump down" or "no jump") and celeration turn (a "turn up," "turn down," or "no turn."). In each description, the effect that occurred immediately after CSS was inserted is described first. If there were additional major changes after that, each of these is also described and delimited with semicolons.

As can be seen in Table 9, the decelerative power of CSS is evidenced by the jumps and turns that occurred right after CSS was first inserted. All 11 showed jump downs at CSS introduction. And after those jumps, only 1 of the 11 participants showed a celeration turn up, 3 showed no change in trend (i.e., showed no turns) and 7 showed celeration turn downs.

Table 9

Changes in Frequency Jumps and Celeration Turns after CSS Introduction for Participants who did not Show Jump Downs to Zero or Near-zero

Participant #	Change Effect Description
6	Jump Down, Turn Down (wk 49);
16	Jump Down, No Turn (wk 70); No Jump, Turn Down (wk 104); No Jump, Turn Up (wk 117)
24	Jump Down, No Turn (wk 93)
27	Jump Down, Turn Down (wk 95); No Jump, Turn Down (wk. 116, at change from GED-1 to GED-4)
28	Jump Down, Turn Down (wk 96)
30	Jump Down, No Turn (wk 104)
36	Jump Down, Turn Up (wk 109); No Jump, Turn Down (wk 135, during treatment)
37	Jump Down, Turn Down (wk 114)
48	Jump Down, Turn Down (wk 136)
50	Jump Down, Turn Down (wk 139)
59	Jump Down, Turn Down (wk 150)

Comparison of overall improvement of high and low functioning participants

We divided the participants into two groups according to level of cognitive functioning and compared the improvement of the two groups. We used two different methods for classifying each participant as either higher or lower functioning, and analyzed the data separately for each method.

Results when MR diagnosis was used to classify participants. In Table 10, the improvement shown by participants who had been diagnosed with MR is compared with those who were not so diagnosed. For the 28 participants *without* an MR diagnosis, the medians of their individual mean weekly frequencies during baseline and treatment phases were 25.2 and 0.06 respectively. This represents an overall improvement (reduction) by a factor of 25.2 ÷ 0.06 = 420 which is a reduction of 99.8%. For the 32 participants *with* an MR diagnosis, the medians of their individual mean weekly frequencies during baseline and treatment phases were 98.5 and 0.64 respectively. This represents an improvement (reduction) by a factor of 98.5 ÷ 0.64 = 154, which is a reduction of 98.4%. In other words, the non-MR participants showed 420÷154 = 2.7 times more overall improvement (decrease) than did the MR participants. An overall reduction of 100% was achieved by only 38% of the MR group, but by 68% of the non-MR group. A reduction of 95% or greater was achieved by 81% of the MR group, but by 100% of the non-MR group.

Table 10

Improvement of MR and Non-MR Participants

	MR	Non-MR
1. No. of Participants	32	28
2. Median of the Individual Mean Weekly Frequencies (All Baseline Weeks)	98.5	25.2
3. Median of Individual Mean Weekly Frequencies (All Treatment Weeks)	0.64	0.06
4. Overall Reduction from Baseline (Divide-by-Factor) Calculated as Row 2 divided by Row 3	154	420
5. Overall Reduction from Baseline (Percent) Calculated as (Row 2-Row 3)÷Row 2	99.4%	99.8%
6. Percent Achieving 100% Overall Reduction	38%	68%
7. Percent Achieving 95% or Greater Overall Reduction	81%	100%
Superiority of CSS with Non-MR group = 420 ÷ 154 = 2.7 times greater overall reduction from baseline		

We completed a χ^2 analysis with respect to two variables: MR classification (MR vs. No MR) and chart classification from Table 4 (the number of students achieving a zero or near-zero reduction vs. the number in all other classifications). In Table 11, these data are presented. The result of the analysis was significant, χ^2 (1) = 13.13, $p < .001$.

Table 11

Frequency Table of MR and Chart Classification

	MR	No MR	Total
No. classified as achieving zero or near-zero reductions from Table 4.	20	28	48
No. in all other classifications from Table 4.	12	0	12
Total	32	28	60

Results when conversation skill was used to classify participants.

As a second approach, we ignored the participants' diagnoses, and classified them informally as either higher or lower functioning according to whether or not they could carry on a meaningful conversation with a normal adult. Five JRC staff members, who knew the students well and who were unaware of the purpose of the categorizations, made these judgments independently. The final assignment of each student to a group was determined by majority decision.

The results based on this conversational skills standard are presented in Table 12. A total of 38 participants were judged to be high functioning by this standard. They engaged in a median (of the individual mean weekly frequencies) of 28.56 aggressive behaviors during the baseline period and a median (of the individual mean weekly frequencies) of 0.07 aggressive behaviors during the treatment period. This represented an improvement (reduction) by a factor of 408. The 22 participants who were judged to be low functioning by this conversation skills standard displayed a median (of their individual mean weekly frequencies) of 94.83 per week and 1.37 per week, respectively, during baseline and treatment phases. This represented an improvement (reduction) of ÷ 69.9. The high functioning participants showed 5.8 (408 ÷ 69.9) times more overall improvement (decrease) than did the low functioning group.

An overall reduction of 100% was achieved by only 14% of the low functioning group, but by 68% of the high functioning group. A reduction of 95% or greater was achieved by 73% of the low functioning group, but by 100% of the high functioning group.

Need for emergency takedown restraints before and after CSS introduction

We compared the number of emergency takedown restraints that participants underwent during the 30 days immediately prior to CSS introduction with the number they underwent during the 30 days immediately after CSS introduction. Figure 4 shows this data. Figure 4 does not show successive calendar days on its horizontal axis. This axis shows days prior to, and subsequent to, CSS introduction. Irrespective of on what calendar day, during the 3-year period, each takedown restraint occurred, we totaled, across all 60 participants, all emergency takedown restraints that occurred on the 1st day ***before*** CSS introduction, all that occurred on the 2nd day ***before*** CSS introduction, etc. The data point immediately to the ***left*** of the intervention line in Figure 4 represents the total for the 1st day before CSS introduction, the data point that is second to the left from the intervention line is for the 2nd day before CSS intervention, etc. We also totaled all emergency takedown restraints that occurred on the 1st , 2nd , 3rd ,

Table 12

Improvement of Low and High Functioning Participants (Using an Informal Judgment of Conversation Skills to Determine Level of Functioning)

	Low	High
1. No. of Participants	22	38
2. Median of the Individual Mean Weekly Frequencies (All Baseline Weeks)	94.83	28.56
3. Median of the Individual Mean Weekly Frequencies (All Treatment Weeks)	1.37	0.07
4. Overall: Reduction from Baseline (Divide-by-Factor) Calculated as Row 2 divided by Row 3	69.9	408.0
5. Overall: Reduction from Baseline (Percent) Calculated as (Row 2-Row 3)÷Row 2	98.6	99.8
6. Percent Achieving 100% Overall Reduction	14	68
7. Percent Achieving 95% or Greater Overall Reduction	73	100

Superiority of CSS with high functioning group = 408 ÷ 69.9 = 5.8 times greater overall reduction from baseline.

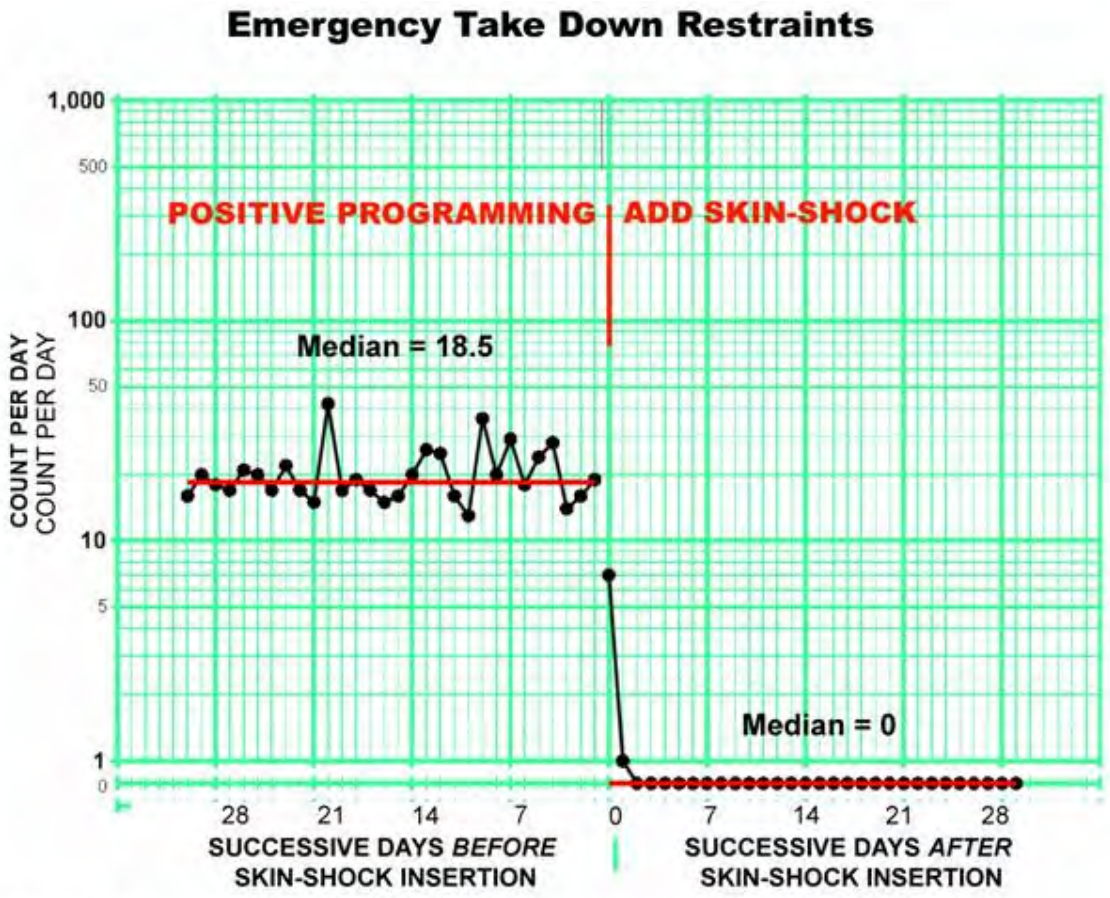

Figure 4. Emergency takedown restraints for the 30 days before and after the introduction of skin-shock.

etc. day *after* CSS introduction and these totals are shown in the first, second, third, etc. data points that appear to the *right* of the intervention line.

The participants, as a group, had a median of 18.5 emergency takedown restraints per day during the last 30 days before CSS introduction and a median of 0 emergency takedown restraints per day during the first 30 days after CSS introduction. Because each takedown restraint involved the joint action of 2-8 staff members, as well as one other staff member whose only role was to observe the restraint, and because each instance was recorded on a restraint form at the time of the restraint, measures to insure interobserver reliability were not deemed necessary.

Use of Psychotropic Medication

Forty-eight of the 60 participants (80%) were taking a total of 159 psychotropic medications when they enrolled at JRC. We measured the total number of participants taking psychotropic medications and the number of medications they were taking at the following points in time: (1) when the participants enrolled at JRC (2) when CSS was introduced; and (3) when the participants left JRC, or December 1, 2007 for those who still resided at JRC on that date. Both the date of enrollment and the date of departure (or on December 1, 2007 for those who were still at JRC) were, for some participants, outside of the 3-year window within which the aggression data reported above was obtained. The results are summarized in Table 13. By the date on which CSS was inserted, the number of *participants* taking psychotropic medications had already been reduced by 64.58%. By the date on which the participants departed from JRC (or on December 1, 2007 for those who were still at JRC), the number of participants taking psychotropic medications had been reduced by 93.75%. The total number of psychotropic *medications* that were being taken by participants had been reduced by 74.21% by the time of CSS introduction and by 97.48% by the time the student left JRC (or by December 1, 2007, for those still at JRC).

Table 13

Use of psychotropic medications

	On Date of Enrollment		On Date of CSS Introduction[a]		On Departure Date or 12/1/07, whichever earlier		
	No.	Percent of all 60 participants	No.	Reduction (Percent)	No.	Reduction (Percent)	Reduction (Divide-by-Factor)
Number of participants taking psychotropic medications	48	80.00%	17	64.58%	3	93.75%[b]	48/3 = ÷16
Number of psychotropic medications being taken.	159		41	74.21%	4	97.48%[c]	159/4 = ÷39.8

[a]In those cases in which the GED-1 was used first and was later switched to the GED-4, the date of the GED-1 introduction was used. [b]One participant stopped receiving CSS treatment on 6/25/06, after the end of the 3-year period of this report (the school district removed CSS from his IEP on grounds that it was a methodology, not an IEP objective) and resumed one psychotropic medication on 6/24/07. If this student is not counted, the percentage reduction would be 46/48 = 95.83%. [c] If the student mentioned in table footnote b (who stopped receiving CSS treatment on 6/25/06 and who resumed one psychotropic medication on 6/24/07) is not counted in the calculation, the percentage reduction would be 98.11%.

Comparison of injuries to staff members before and after CSS introduction

We compared the number of injuries that the participants caused to staff members by their aggressive behaviors during baseline with the number they caused during treatment. These were significant injuries that required nursing or other medical attention. For example, during baseline the following injuries were recorded: bites (50), contusions (bruises) (39), strains (18), head injuries (11), sprains (10), lacerations (4), pains (3), abrasions (3), headaches (2), temporomandibular joint problem (1), exposure to blood-born pathogens exposure (1), nasal injury (1), nasal fracture (1), tooth fracture (1), cracked tooth (1). The data is shown in Table 14. Injuries decreased from 146 before CSS introduction to only 7 after. The number of injuries per participant-month, after CSS introduction, decreased by a factor of 25.5, which was a 96% reduction.

Table 14

Aggression-caused injuries to staff members

	No. of Staff Injuries Caused by Participants	No. of Participant -Months	Injuries per Participant -Month
Baseline phase	146	615	0.2274
Treatment phase	7	751	0.0093
Decrease (divide-by-factor)			÷ 25.5
Decrease (percent)			96%

DISCUSSION

This retrospective analysis represents the largest set of data that has been reported on the effects of CSS on aggression. A total of 109.3 person-years (5,685 person-weeks, 39,795 person-days or 955,080 person-hours) of continuously recorded data on aggression are reported. Our results suggest that CSS delivered from the GED, when used as a supplement to a comprehensive behavioral program that involved powerful and consistent reinforcement and educational procedures, was extremely effective in decelerating aggressive behaviors to zero or near-zero levels and in maintaining the behaviors at those levels for periods of up to three years.

The only two treatment outcome reviews that have addressed the treatment of aggressive behaviors are those of Cataldo (1991) and Carr (1999). Unfortunately, although the Cataldo review surveyed 137 studies, only 3 of these studies, involving only 4 participants, dealt with the use of CSS to treat aggression. The low percentage (60%) that reached treatment effectiveness (90% or greater reduction from baseline) found in those studies may have been due to factors such as an inadequately robust CSS stimulus, lack of consistent treatment, and/or insufficiently powerful positive programming procedures.

In the present study, positive behavioral education and treatment, supplemented by CSS, proved to be approximately twice as effective in treating aggression as were the positive behavior support procedures reviewed in the Carr et al. 1999 report. By “twice as effective” we mean that 100% of our participants reached treatment effectiveness (90% or greater reduction from baseline) as compared with only 55.5% who achieved this in the Carr et al. report. Two factors make the superiority of the present results all the more notable. First, the treatment projects reviewed by Carr et al. had been chosen by their authors for submission for publication. Authors of such studies rarely submit failures or negative results for publication. By contrast, in the present study no selection of participants was made. Every single participant whose program was supplemented with CSS during a 3-year period was included with the exception of 7 who were absent from the treatment for such long periods that they did not receive a

consistent treatment program, four other because of logistical difficulties in obtaining consent, and 1 guardian who declined to participate. Second, most of the participants in the present study probably had substantially more severe behaviors than those in the Carr et al. review because they had all previously been rejected, expelled or tried without success in programs that rely solely on positive behavior support procedures (see Israel, Blenkush, von Heyn, & Sands, 2009).

The finding that the positive programming/CSS combination used in the present study almost doubled the effectiveness (in terms of the percentage that reached the 90% or greater reduction standard) that was found in the positive behavior support papers reviewed by Carr et al. is important because many persons and agencies—such as TASH and the Association for Positive Behavior Support—assert that even the most severe problem behaviors can be effectively treated with Positive Behavior Support methods alone (TASH, n.d.; APBS, 2007). Using or choosing a treatment that is 50% less effective than would otherwise be possible might be justified if the aggressive behaviors to be treated are not severe. If the aggression is severe, however, and might result in serious harm to others or to the individual him/herself, choosing a relatively ineffective treatment over one that has proven to be twice as effective raises its own ethical issues.

Because the number of GED applications was always fewer than the number of aggressive behaviors that were tallied, Table 6 can be used to set an outside limit on the number of GED applications that were applied to consequate aggression. Using this data, one can see that no more than 3,764 applications of the GED-1 and GED-4 were made for these 60 participants during the 3 years in question. The median participant received fewer than 0.14 applications per week, which is approximately 1 application every seven weeks. The range was from 0 per week (e.g., participant 29) to 12.15 per week (participant 27). In some cases the number of applications necessary to control the participant's aggression was remarkably low. Participants 19, 44, 54, 55, 56, 57, and 60 did not receive any applications at all after the first week. Participants 2, 10, 11, 31, 33, 34, 39, 42, 45, 52 received only 1 or 2 applications after the first week.

The failure to find significant adaptation in most of the participants is noteworthy. For almost all participants, aggressive behaviors remained at a low level, or continued to decelerate over time, even when the CSS contingency remained in place for periods of up to three years. This finding is significant in light of previous reports of adaptation associated with SIBIS, the skin-shock device that has been used in most CSS studies during the past 17 years (e.g., Ricketts, Goza, & Matese, 1993; Williams, Kirkpatrick-Sanchez, & Iwata, 1993).

A possible limitation of this study was the lack of interobserver reliability. Due to financial considerations, these measures were not obtained. However, it is important to note that those who counted aggressive behaviors completed a significant amount of training and there were various mechanisms within the program to maintain treatment integrity, including live and video monitoring of the staff by trained supervisors. Additionally, the data were collected across environments and represent a complete picture of the total daily behavior frequency of each participant as opposed to session data.
Although gradual removal or fading of the GED was possible for many participants (38%), CSS treatment may, for some individuals with significant developmental disabilities, be prosthetic, i.e., required on a long-term basis—as is the case with eyeglasses, hearing aids, prosthetic limbs, and many drugs—rather than curative. An appropriate prosthetic device or environment enables a behaviorally handicapped individual to behave normally in a normal environment (Lindsley, 1964) and markedly enhances the individual's quality of life.

Our results suggest that CSS was effective not only with lower functioning individuals, such as those with severe or profound retardation and autism, but also with individuals with normal or near-normal cognitive functioning. When presence or absence of an MR diagnosis was used to determine level of functioning, CSS proved to be almost three times more effective in overall reductive power with higher

as compared with lower functioning participants. When, instead, an informal conversation skill standard was used to determine level of functioning, CSS was almost six times more effective in terms of overall reductive power with higher functioning participants than with lower functioning participants The greater effectiveness of CSS with the higher functioning participants was probably due to the fact that for these participants their aggressive behaviors were modified not only by the direct application of contingencies, but also because their superior verbal behaviors enabled their aggression to be affected by rule-governed behavior (Skinner, 1969) as well.

This finding that CSS was more effective with the higher functioning participants may be true of other punishers as well. Foxx and Livesay (1984), for example, found that "higher functioning individuals treated with overcorrection showed longer and better treatment effects than lower functioning individuals"(Foxx, 2003, p.11). A more detailed analysis of the differential effect of CSS on individuals with differing cognitive levels and verbal skills merits future study.

Detection of the superior overall decelerative effect of CSS on the aggression of higher functioning participants was made possible by examining the factor by which the baseline value divided rather than by examining the percentage reduction. For example, in Tables 10 and 12, if one compares only the percentage reduction of the higher versus lower functioning participants, the small differences seen—0.4% when the criterion was presence or absence of an MR diagnosis, and 1.2% when it the standard was an informal assessment of conversational skills—do not reflect the true difference in decelerative power of CSS as between the two groups. Only when we compared the decreases of the two groups by using the reductive factors does the greater improvement for higher functioning participants become clear. Graf and Lindsley (2002) have cautioned researchers against the weaknesses of percent as a measure.

The practice of employing skin-shock with "higher functioning" individuals has been criticized by some. These concerns should be weighed, however, against the fact that some of the higher functioning participants in the present study, unlike many of the lower functioning participants, have been able, with the temporary help of this treatment, to turn their lives around, live independently and become future taxpayers. Many of them function at a level where they can discuss their treatment and reflect on its value to them, something several of them have done at public hearings before Massachusetts legislative committees that have considered bills that would ban the use of skin-shock as a behavioral treatment.

Despite the fact that we administered up to 3,764 GED applications to the participants, the only negative side effect found was an occasional temporary discoloration of the surface of the skin that cleared up within a few minutes or a few days. The most common immediate collateral behavior associated with the application of skin shock was a temporary tensing of the body that some participants showed while the application was applied. Other collateral behaviors were avoidance responses such as attempts to remove the device or grab the transmitter, and temporary emotional behaviors. Future research should be devoted to the prevalence and mitigation of collateral behaviors associated with skin shock.

The absence of negative side effects of CSS treatment with the GED has been confirmed by van Oorsouw, Israel, von Heyn, and Duker (2008), who found either significant improvement or no change in positive verbal and nonverbal utterances, negative verbal and nonverbal utterances, socially appropriate behaviors, and off task behaviors.

The procedures used in this study eliminated the need to use emergency takedown restraint with the participants. The number of such restraints, when totaled across the entire group of 60 participants, dropped from a median of 18.5 per day before CSS introduction to a median of 0 per day after. Each such restraint lasted between 20 and 120 minutes and involved from 2-8 staff members. From the participant's perspective, the elimination of such takedowns avoided the humiliation that can be involved in

undergoing them, and resulted in large savings of time that could now be devoted to classroom learning instead of to being restrained on the floor. Duker and Seys (2000, 1996) have also reported the reduction of restraint as a product of the use of CSS.

By eliminating the need for emergency takedown restraints, CSS treatment enhanced the participants' safety by enabling them to avoid a procedure which, when not carried out properly, can be dangerous. The reported number of deaths in the United States each year due to the use of manual or mechanical restraint has been estimated to be in range between 50 and 125 per year, with some estimates even higher (Conner, 2006). The figure for injuries is probably many times higher.

Our data also shows that the type of behavioral treatment reported here made it unnecessary, in most cases, to continue to use psychotropic medication to control aggression. This fact also enhanced the safety of the participants in this study. Chyka (2000) summarized the number of deaths caused by adverse drug reactions (to psychotropic medications) in 1995 as reported by the US Food and Drug Administrations (FDA). He found that 848 people died as a result of such reactions. This number does not include deaths or other injuries due to human error in medication administration.

It should be noted that these two dangerous procedures—psychotropic drugs and emergency takedown restraint—both of which can be avoided by using the procedures described in this report—are two of the most common procedures that programs normally use to deal with severe aggression.

Anecdotally, we observed other positive side effects. Once the participants' aggression diminished, a cascade of other positive results began to follow naturally. Participants began succeeding, sometimes for the first time, in passing their behavioral contracts. As a result, they began to earn more rewards, advance to residences and classrooms with more privileges, and generally improve their quality of life. Their parents and siblings began to take them home and for outings more often. Many participants were now attending school and learning new skills for the first time in years. Many began to make meaningful plans for finishing public school, obtaining further education, obtaining competitive jobs, and leading a normal, institution-free lives.

Paradoxically CSS, whose application caused some temporary discomfort, had the longer-term effect of improving the participants' self-concept, outlook, safety, and happiness when it was used as a supplement to a powerful positive behavioral program to treat aggression as well as other major problem behaviors. During the treatment phase, many of participants in this report developed optimism for their future where previously there had been none. Faces that appeared to have a permanent scowl when they had first enrolled at JRC, were now relaxed, happy, and smiling. Many who had arrived at JRC with depression found that this was no longer a problem when they were behaving well, earning frequent rewards, and achieving goals. In some cases the participants' improved behaviors even enabled them to lose their previously stigmatizing diagnoses.

The beneficial effects of supplementary CSS treatment were so clear that some participants in this study *asked* to be able to go on GED treatment because they could see how much the quality of life had improved for other participants who had already started the treatment. It is not an exaggeration to state that for many of these participants supplementary CSS treatment helped them to turn their lives around and orient them in a positive direction. Future research should be directed to examining these anecdotally noted effects in a scientific fashion.

These observations are consistent with the reports that the effectiveness of CSS in reducing problem behaviors tends to be associated with a wealth of positive side effects (Linscheid et al., 1990; Matson & Taras, 1989) and that the positive side effects tend to far outnumber any negative side effects associated with CSS (Salvy et al., 2004; Linscheid, Pejeau, Cohen, & Footo-Lenz, 1994; Linsheid et al., 1990; Matson & Taras, 1989; Carr & Lovaas, 1983). Future studies should seek to quantify these positive changes.

If an individual's repertoire is too filled with aggressive or other inappropriate behaviors, it can be difficult if not impossible to teach that person much in the way of new skills. In that respect, effective use of aversives functions for some participants as a "gateway" to the use of positive programming in that it enables such programming to occur for the first time. As Johnston (2006) has noted, decreasing strong problematic behaviors in an individual's repertoire can open the way for less frequent, but desirable behaviors to emerge, be rewarded, and become stronger.

Every surgical, dental, or medical treatment involves discomfort, risks, or costs on the one hand, and expected benefits on the other. For most persons, a reasonable approach is to weigh the discomfort/risks/costs against the potential benefits in deciding whether to undergo or approve the treatment. The data presented here help to illustrate one aspect of the benefits – the immediate or rapid elimination of an intractable behavior problem that, in most cases, had resulted in years of ineffective treatment that included numerous psychotropic medications and physical restraints.

There exists a very small population of individuals who engage in severe problem behaviors that do not respond to typical forms of intervention. Although some individuals may prove to have aggression so severe that it will not respond to the procedures described in this study, the fact is that every single participant in the present study did respond well and benefit from this treatment. Hopefully behavioral psychologists may some day develop totally positive treatments for severe aggression. Until then, our data suggest that CSS, delivered by the GED and accompanied by a consistent program of educational growth and comprehensive behavior programming, can be very helpful in producing clinically important reductions in aggressive behaviors across a broad spectrum of individuals.

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Author Contact Information

Matthew L. Israel
The Judge Rotenberg Educational Center
250 Turnpike Street
Canton, MA 02021
(781) 828 – 2202
email: m.israel@judgerc.org

Robert E. von Heyn
The Judge Rotenberg Educational Center
250 Turnpike Street
Canton, MA 02021
(781) 828 – 2202
email: r.vonheyn@judgerc.org

Nathan A. Blenkush
The Judge Rotenberg Educational Center
250 Turnpike Street
Canton, MA 02021
(781) 828 – 2202
email: n.blenkush@judgerc.org

Author Note

We dedicate this paper to the loving memory of Dr. Patricia M. Rivera and her remarkable dedication, patience, and commitment to individuals with severe problem behaviors and their families.

Matthew L. Israel, Nathan A. Blenkush, Robert E. von Heyn, and Patricia M. Rivera
The Judge Rotenberg Educational Center.

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Correspondence concerning this paper should be sent to: Matthew L. Israel

Appendix

The Frequency of Aggressive Behaviors During CSS Introduction Week for each Participant.

Participant	Frequency of Aggression During CSS Introduction Week
1	9
2	10
3	25
4	0
5	1
6	182
7	3
8	77
9	13
10	69
11	3
12	0
13	16
14	1
15	170
16	27
17	19
18	98
19	30
20	3
21	3
22	219
23	0
24	5
25	1
26	0
27	44 (15)
28	223
29	21 (0)
30	94
31	1
32	48
33	1
34	2
35	3
36	50
37	200
38	0
39	23
40	17
41	0
42	0
43	36
44	19
45	0
46	60
47	7

Appendix (Continued)

The Frequency of Aggressive Behaviors During CSS Introduction Week for each Participant.

Participant	Frequency of Aggression During CSS Introduction Week
48	33
49	2
50	43
51	68
52	24
53	3
54	5
55	39
56	16
57	962
58	27
59	241
60	0

Note: Participants 27 and 29, who were switched from GED-1 to GED-4, have two CSS introduction weeks. The frequency of aggressive behaviors in the second CSS introduction week (when GED-1 was switched to GED-4) is presented in parentheses.