Effects of Progressive Delay Self-Control Training on Impulsive Choices of Elementary Students with EBD

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

Introduction

Instead of working quietly to later obtain a pleasant outcome (e.g., teacher praise, a good grade, access to more preferred activities), some children instead engage in undesirable behaviors that produce less pleasant but more immediate benefits (e.g., teacher reprimands, temporary escape from work, brief access to a relatively preferred activity). A response that produces a small but immediate benefit at the cost of a delayed but superior one is considered impulsive, while the alternative is conceptualized as self-controlled (Madden & Johnson, 2012; p. 12). One way to model self-controlled, or conversely, impulsive behavior is to arrange choices between a smaller, immediately available reward (i.e., smaller, sooner reward; SSR) and a larger reward available after a delay (i.e., larger, later reward; LLR). Experimenters may arrange choices with a variety of delays to the LLR to estimate the longest delay at which a person will select the LLR before reversing their preference and settling for the SSR. Increasing delays at which individuals make self-controlled choices has been the aim of a number of treatment studies focused on impulsivity. Progressive delay training (PDT; Dixon et al., 1998) is the primary method used to directly treat impulsive choice making in this model.

Progressive delay training begins with presenting a set of choice trials in which both the smaller and larger rewards are available immediately. Assuming a participant prefers the larger reward when both options are immediate, experimenters then progressively increase delays to the larger reward. The smaller reward remains immediately available across successive trial sets. For example, a PDT session may include multiple choice trials, each of which involve an implementer asking a participant to choose between one potato chip now and three potato chips after waiting for 10 s. After the participant meets some mastery criterion (e.g., LLR chosen in four of five trials) at the 10-s delay, the implementer increases the delay by a designated increment (e.g., 5 s) and delivers another set of choice trials. Choices are identical across successive trial sets with the exception of delays to the LLR, which increase based on preference for the LLR at a previous delay. Progressive delay training ends once a participant reliably chooses the LLR at a terminal delay.

In one of the earliest applications of PDT, Schweitzer and Sulzer-Azaroff (1988) recruited preschoolers who had been referred by their teachers for engaging in impulsive behavior in the classroom. They found that as a result of PDT, delays at which children's preferences reversed from the LLR to the SSR increased from between 1.7 and 51.7 s pre-training to between 37.5 and at least 90 s post-training. Somewhat similarly, Dixon and Falcomata (2004) used PDT to increase delays at which a man with an acquired brain injury would choose to engage in a physical therapy task (i.e., hold his head up off his chest and shoulders) until he received 30 s of access to a video rather than choosing to access the video immediately for 15 s. Dixon and Falcomata required engagement in the physical therapy task during delays, but did not report making other activities available. These results indicate that simply progressively increasing delays to the larger reward without providing access to additional activities or stimuli may (a) treat impulsive choice-making, and (b) increase the time a person will engage in a target response. In addition to being used in isolation, PDT is commonly supplemented by other variables that may increase self-controlled choice making. Embedding an intervening activity during delays to the LLR is one modification to PDT that has been evaluated extensively. In fact, Dixon and Cummings (2001) implemented PDT with a third option. Participants could choose the standard SSR or LLR, or a second LLR option in which they matched pictures to objects during the delay. Dixon and Cummings found that PDT with the matching activity increased delays at which participants selected the LLR. Participants also preferred the LLR with the matching requirement to the LLR alone as delays increased.

Intervening activities may also increase the efficacy of PDT compared to PDT alone, at least for some participants. Dixon, Rehfeldt, and Randich (2003) directly compared the effects of PDT alone to PDT with an intervening activity (i.e., placing foam cubes into a plastic basket) using an alternating treatments design. Progressive delay training with the activity was more effective at increasing allocation to the LLR for two of three participants, particularly as delays increased. One participant allocated a greater percentage of responses to the LLR under the PDT alone condition compared to the PDT and intervening activity condition. Other response requirements embedded in PDT have included physical therapy tasks (Dixon & Falcomata, 2004), functional skills from treatment plans (e.g., staying in designated seat, using an exercise band; Dixon et al., 1998), identifying objects on flash cards or repeating a rule about waiting (Binder, Dixon, & Ghezzi, 2000), and sorting cards (Dixon & Holcomb, 2000). The evidence from this group of studies indicates intervening activities increase the probability of a self-controlled choice.

However, PDT alone may be worth investigating further, given these findings may be interpreted to mean waiting is “easier” when there are stimuli with which to interact. Thus, waiting and engaging in a response requirement when there is nothing to do (e.g., head holding [Dixon & Falcomata, 2004]) may be a “harder” skill to master, although it is a skill that is often required in school settings (e.g., waiting quietly for help when stuck on a math problem, in line at the water fountain, or while a teacher prepares materials or supports another student). In these scenarios, immediate “rewards” in the form of reprimands, peer attention, or unsanctioned access to preferred items or materials may be available to students contingent on disruptive behavior at the cost of larger, later rewards associated with following school rules.

Regardless of whether intervening activities are involved, additional procedural variations on PDT have promise for increasing the probability of a self-controlled choice. One variation involves simply providing a rule describing contingencies (Benedick & Dixon, 2009). Benedick and Dixon evaluated the effects of PDT with and without a rule (i.e., "it is better to choose the green [LLR] card") on choices of adults with dual diagnoses of intellectual disabilities and mental illness in a residential treatment center. They found that both versions of PDT increased delays at which participants selected the LLR, but all three participants performed best in rule conditions.

Like delivering a rule, signaling delays may also increase the probability of choosing the LLR. Vollmer and colleagues modeled impulsive problem behavior by programming SSRs for aggression and LLRs for mands. They compared response allocation under two conditions, unsignaled delays and signaled delays. Implementers signaled delays for each of two participants by (a) placing a hand on the potato chip bag as the delay began and (b) displaying a countdown of the delay on a visual timer, respectively. Vollmer and colleagues found that signaling delays, regardless of method, greatly reduced impulsivity (i.e., aggression). For one participant, experimenters gradually increased delays up to 10 min using a visual timer to signal delays. Providing a rule and signaling delays may, like intervening activities, increase self-controlled choice making in the context of PDT.

PDT in its several forms has been effective for a wide range of participant populations. Populations include adults with intellectual and/or developmental disabilities (I/DD; Benedick & Dixon, 2009; Dixon et al., 1998; Dixon & Holcomb, 2000; Dixon et al., 2003) and adults with traumatic brain injuries (Dixon & Falcomata, 2004; Falcomata & Dixon, 2004). Young children with a variety of developmental characteristics have also learned, via PDT, to choose the LLR at greater delays. These include preschool children referred for impulsive behavior (Schweitzer and Sulzer-Azaroff, 1988), children with autism or developmental disabilities (Dixon & Cummings, 2001; Gokey, Wilder, Welch, Collier, & Mathison, 2013; Vollmer et al., 1999), and even infants (Riviere & Darcheville, 2001). In these experiments, variations of PDT have increased delays at which participants make self-controlled choices, and in some cases, also reduced undesirable behavior (e.g., disruptive behavior [Dixon and Cummings, 2001]; aggression [Vollmer et al., 1999]) during choice trials.

Given that PDT has potential for increasing delays at which children select an LLR, as well as reducing problem behavior, it is surprising PDT has not been evaluated for its effects on the choices of children with emotional and behavioral disorders (EBD). These children receive special education services based on severe and persistent patterns of problem behavior that impede learning but cannot be attributed to intellectual, health, or other factors (Individuals with Disabilities Education Act, 2004).

Children with EBD may be ideal candidates for impulsivity treatment because impulsivity and symptoms of EBD often co-occur. Conduct problems, or externalizing problem behaviors, are often comorbid with impulsivity (i.e., they co-occur at a greater than random rate; Waschbusch, 2002). For example, Eisenberg and colleagues (2001; 2009) measured the externalizing problem behavior (e.g., aggression, disruption) and impulsivity in elementary school children via teacher and parent reports (i.e., Teacher Report Form and Child Behavior Checklist [CBCL]; Achenbach, 1991a, 1991b). They found externalizing behavior was significantly associated with high impulsivity according to parent and teacher ratings compared to other behavioral profiles (i.e., internalizing behavior, typical behavior). Conduct Disorder (CD) diagnoses themselves are also associated with high levels of impulsivity. White and colleagues (2014) measured delay discounting, an index of impulsivity based on choices between SSRs and LLRs across a range of delays, in youth with CD. They found youth with CD discounted more steeply by delay (i.e., were more impulsive) than control participants. As another example, Wilson and Daly (2006) measured delay discounting in juvenile offenders who had been incarcerated for offenses ranging in severity from property-related to serious violent crimes. Juvenile offenders discounted more steeply by delay (i.e., were more impulsive) than counterparts who had never been detained. Taken together, results of these studies indicate impulsivity is particularly likely among children with externalizing behavior problems.

The prevalence of impulsivity among children with conduct problems warrants a closer look at how their behavior operates in educational settings. Reed and Martens (2011) demonstrated that impulsivity predicted the difference in levels of on-task behavior in immediate versus delayed reward conditions among sixth grade students. The more impulsive students were according to a delay discounting measure, the worse they performed in delayed relative to immediate reward conditions. Although severe problem behavior was not the focus in this study, it is relevant to note that behavior that interferes with learning (i.e., off-task behavior) is more likely in children with impulsivity when rewards are delayed.

Findings of Neef and Lutz (2001) more directly demonstrated the effects of immediate versus delayed rewards on problem behavior in a child who was impulsive. Damien was a 10-year-old boy who was hospitalized due to the severity of his behavior problems, and who was relatively sensitive to the immediacy of rewards (i.e., likely to allocate responses to SSRs). Neef and Lutz implemented a schedule of differential reinforcement of low rates (DRL) of disruptive behavior during classroom instruction in two conditions: immediate rewards (i.e., right after class) and delayed rewards (i.e., at the end of the day). The DRL schedule decreased disruptive behavior relative to baseline when reinforcement was immediate, but not delayed. These findings indicate impulsivity may predict differences in levels of problem behavior in the classroom between immediate and delayed reward conditions. Thus, even though end-of-day rewards are common in school-based interventions, evidence suggests behavioral supports involving immediate rewards are most effective—particularly for students with impulsivity.

Impulsivity is likely in children with severe behavior problems, but may inhibit response to behavioral treatments that involve delayed rewards (e.g., Neef & Lutz, 2001; Reed & Martens, 2011). Given that levels of problem behavior may depend on immediacy of reinforcement for alternative behaviors, directly treating impulsivity, or increasing tolerance for delayed rewards, may be an avenue for improving behavioral outcomes. Because PDT is an established treatment approach for increasing delays at which individuals choose the LLR, a first step toward answering the question of whether treating impulsivity results in improvements in classroom behavior is to evaluate the efficacy of PDT for children with EBD.

Purpose

The purpose of this study was to evaluate the effects of PDT on the impulsive choice-making of young children with EBD who have difficulty waiting quietly and safely in the absence of other activities or stimuli. Specifically, we aimed to answer the question, does PDT with a school rule-following requirement increase delays at which young children with EBD make self-controlled choices?

Chapter II

Method

Participants and Setting

Participants included eight children enrolled in first or second grade in a self-contained school for children with EBD. Table 1 displays a summary of participant characteristics. Ages ranged from six (Peter) to seven (remaining participants), and most participants were male (i.e., seven boys; five Black and two White) except for one female participant who was Black. Most participants, excluding Wayne and Natalie, took one or more psychotropic medications daily. Participants had a range of educational labels, including Emotional Disturbance, Other Health Impairments, Speech and Language impairments, Developmental Delays, and Intellectually Gifted. No participants had a label of Intellectual Disability. All participants had FBA/BIPs on file documenting unsuccessful behavioral supports in previous, less restrictive school placements. Target behaviors from FBA/BIPs are also displayed in Table 1. Teachers reported that all their students, including study participants, were more likely to (a) follow the rules when rewards were immediate versus delayed and (b) engage in problem behavior when required to wait quietly with nothing to do.

To be included in this experiment, participants had to (a) select the larger reward in three consecutive trials in which both the smaller and larger reward were available immediately, and (b) select the SSR in 3 or more trials when delays were relatively lengthy (i.e., $\geq$ 3 min). All study procedures were approved by the Vanderbilt University Institutional Review Board and the school district's research, assessment, and evaluation committee. Research staff (i.e., graduate students in special education) conducted choice sessions with individual participants in unoccupied rooms (e.g., library, cafeteria, home economics room) based on space and participant availability.

Materials

We used a pair of white 3 in x 5 in index cards to represent choice options (i.e., SSR and LLR). The card corresponding to the SSR displayed one image of the reward item. The card corresponding to the LLR displayed two images of the reward item. We used the same set of cards across participants. This set included a pair of cards for each individual reward item, as well as a pair of cards with pictures of an iPad to represent multiple activities. In the progressive muscle relaxation condition, we used an additional card that was green but otherwise identical to the LLR card. We used an iPad® Mini for digital games. We also used a variety of toys including action figures, remote controlled trucks, dolls, and coloring books with markers, crayons, and colored pencils as reward items. Tables 1 and 2 contain comprehensive lists of the games, activities, and toys we made available during choice trials.

Response Measurement

Choice responses. We recorded choice allocation (i.e., SSR or LLR) for each trial for each participant during natural baseline, choice baseline, and PDT trials. Choice was defined as either (a) a verbal statement indicating selection of the SSR or LLR (e.g., “I want to play a little bit right now”), or (b) pointing to or touching a card corresponding to either the SSR or LLR. During natural baseline sessions, we also recorded the latency from the end of the experimenter’s statement to “wait as long as you can for [item], and press the red button when you can’t wait any longer” until the child pressed a button that stopped the timer.

Compliance with rules. During choice baseline and PDT trials in which participants selected the LLR, observers also recorded whether participants followed the rules for the duration of the delay. When participants broke a rule, observers recorded whether and at what time the experimenter ended the trial (see procedures below under “choice baseline with response requirement”). Rules were adapted from school rules and reviewed with teachers. We defined compliance with rules as (a) child sits upright (i.e., head off the desk, or off arms resting on the desk) with entire bottom in chair, all four chair legs on the floor, and feet off of chair seat; (b) child remains silent (i.e., absence of vocalization; excluded coughing and throat clearing); (c) child’s hands, feet, and other body parts or objects are kept to self (i.e., child could not play with or touch materials or objects; excluded touching clothing or self [e.g., cracking knuckles]).

Progressive muscle relaxation. Some participants also underwent a progressive muscle relaxation (PMR) condition (see procedures below under “progressive muscle relaxation”). In this condition, in addition to recording choice and rule-following responses for each trial, observers also recorded whether participants engaged in each PMR response for each body part. Specifically, observers recorded whether participants (a) visibly contracted a group of muscles according to PMR training procedures (e.g., closed eyes, wrinkled nose, tilted head back, hunched shoulders, or clenched fists; see Figure 1) for 3 s or longer and (b) visibly relaxed the same (previously contracted) muscles for 3 s or longer.

Observer Training and Interobserver Agreement

Research staff were trained to code choice allocation, rule following, and procedural fidelity during choice trial sessions. First, the experimenter reviewed datasheets and response definitions with research assistants. Next, the experimenter role-played choice trial procedures while research assistants practiced coding. Finally, research assistants coded videos of the experimenter delivering trials to an actor. Research assistants were qualified to collect study data once they reached 90% or higher agreement with the experimenter’s codes on (a) three natural baseline/magnitude trials, (b) a set of five choice baseline trials, and (c) a set of five PDT trials in the training videos.

The experimenter implemented most study procedures and typically served as the primary coder. A second observer coded choice responses simultaneously and independently on a minimum of 66.7% of sessions per participant and condition with the exception of George during natural baseline trials, on whose responses we did not assess IOA due to scheduling issues. We calculated inter-observer agreement (IOA) on choice responses for six of eight participants in the pre-training natural baseline condition, an average of 82.5% (range, 66.7% to 100%) of sessions per participant in choice baseline, an average of 80% (range, 66.7% to 100%) of sessions per participant across PDT conditions, and an average of 66.7% of sessions per participant, excluding George, in post-training natural baseline trials (see Table 2 for percentages of sessions with IOA by participant and condition). We calculated point-by-point agreement by dividing the number of agreements on binary choice allocation (i.e., SSR or LLR) and binary rule-following by the sum of agreements and disagreements and multiplying by 100 for each session. IOA for choice allocation and rule following was 100% across participants and conditions. Using the same method of calculation, we assessed IOA for PMR responses in 43% of trial sets for George, 83.3% of trial sets for Peter, and 100% of trial sets for Hank. IOA was 96.7%, 83.3%, and 100%, respectively.

Experimental Design

We used a modified changing criterion design to demonstrate correspondence between (a) programmed increases in delay criterion levels across trial sets during PDT, and (b) our dependent variables (i.e., selecting the LLR and following the rules for the duration of the set delay). We included a choice baseline phase to serve as an initial baseline for the changing criterion design. During intervention conditions, we increased the criterion level only after demonstrating stable criterion-level responding in the previous phase (i.e., choosing the LLR in four of five trials). We initially planned to use a multiple baseline design to evaluate effects of PDT on classroom behavior, thus we staggered the introduction of PDT across participants. We also staggered the number of choice baseline trials across participants.

Procedures

Teacher and student interviews. We conducted 10-min interviews with teachers to identify preferred items and activities for each participant and identify times of day to implement self-control training. Preferred items and activities included games on an iPad®, transportation, Shopkins®, and superhero-related activities (e.g., remote-controlled cars, action figures, coloring books, toys). We also briefly interviewed each participant by asking him or her to identify preferred items and activities from the list provided by the teacher as well as name additional preferred items not listed. We used interview data to select items for participant preference assessments.

Stimulus preference assessment. We conducted paired-choice stimulus preference assessments (Fisher et al., 1992) containing items identified in interviews with each participant. Preference assessment results were used to identify moderately- and highly-preferred activities for each participant for use in choice trials.

Behavior management procedures. Because all participants had histories of engaging in problem behavior, we implemented general behavior management procedures to (a) transition safely from sessions back to class and (b) avoid issues related to restricting access to preferred items (i.e., when time to play ended in a given trial). First, we allowed participants to choose a treat (i.e., sticker, eraser, or pencil) to keep if they cooperated with all our choices during a session and relinquished toys and activities when access time elapsed. To ensure appropriate transition back to class, a research assistant held the item the participant selected and delivered it contingent on the participant following the school rules all the way back to the classroom.

Second, during each trial we counted down for the last 5 s of each access period (e.g., SSR = 30 s) and reminded participants they could earn a treat for cooperating with us. We also praised participants for placing materials on the table or handing them to an experimenter when directed. These procedures were sufficient for all participants with the exception of George during his final five sessions. During these sessions, we made a range of end-of-session treats contingent on a range of point totals. Regardless of choice allocation, George earned a point for each trial in which he relinquished the activity when directed and exchanged them for treat(s) at the end of the session.

Self-control training. We conducted all choice trials for natural baseline, choice baseline, and PDT conditions with individual participants in unoccupied spaces in the school building. The SSR was 30 s of access to a preferred activity, and the LLR was 60 s of access to the same preferred activity. In each choice trial, we presented cards representing each choice, but kept activities and toys out of participants' reach until the appropriate delivery time (i.e., immediate or after set delay). When participants did not clearly indicate one choice, we said, "Please choose only one."

Natural baseline. We conducted natural baseline choice trials with the activity ranked highest in participants' preference assessments. In each trial, we asked participants to identify, by telling us or pointing to the card, whether they would rather play "for a little bit" or "for longer". Once a participant indicated a choice, we said, "Please wait as long as you can before playing with [item]. When you can't wait any longer, press the red button." The red button was the stop button of a timer, and we covered the rest of the timer screen so only the button was visible.

Once a participant touched the red button, we delivered the reward item and recorded the time displayed on the timer. We presented this choice for each participant until they selected the larger reward three consecutive times. We completed three to six additional natural baseline trials, following the exact same procedures, after completing PDT.

Choice baseline with rule compliance requirement. Next, we conducted choice baseline, beginning with an early probe for inclusion (i.e., one trial set with a 3 to 3.5 min delay), with each participant. We conducted choice baseline sessions across several weeks. We typically separated trial sets by several days to reduce possible effects of the sequence of delays on participant choices. Choice baseline sessions ranged from 10 to 45 min in duration, depending on delays.

In each session, we reviewed the school rules then provided an overview of the upcoming trial set (i.e., "First you will try each choice, then you will make your own choices"). Participants were offered the choice between "playing for a little bit right now" or "playing for longer after waiting and following the rules" in each trial. If participants selected the LLR, they had to follow the school rules (i.e., wait quietly) during the entire delay to access the LLR. Participants did not have access to other activities or materials during this time, and we did not interact with them during the delay. If participants selected the SSR, we implemented the same delay duration after the SSR was consumed. We did this to control for total trial duration across choice options. We did not provide instructions to the participants to follow the rules during the post-SSR delay, but otherwise procedures were the same (i.e., they did not have access to any materials or activities). We did not interact with participants during post-SSR delays except to say "it's time to wait," if a participant asked a question.

Each trial set included seven trials in which we presented the same two cards we used in natural baseline trials. One card displayed one image of the reward item (SSR), and the other, two images (LLR) to communicate the proportional difference in play time between the two options. The first two trials in each set were forced-choice trials, in which we prompted participants to sample each option (i.e., SSR and LLR). We flipped a coin or had participants flip the coin before each trial set to determine the order of the forced-choice trials. When we prompted participants to try the LLR, we reminded them to “make sure you follow the rules the whole time to get to play for longer.” We also briefly praised compliance when participants followed the rules for the duration of the delay. When participants did not comply with rules during forced-choice trials, we redirected them but still allowed them to access the LLR, explaining that “this one is just for practice.”

The remaining five trials were free-choice trials, in which participants chose and accessed either the SSR or LLR. In free-choice trials, we presented both choice cards at an equal distance from the participant. We randomized the position of each respective card by shuffling them prior to each trial. In each trial in which a participant selected the LLR, we reminded him or her to follow the rules the whole time to get to play for longer. We also delivered brief praise in each trial contingent on compliance with rules during the duration of the delay to the LLR. When a participant did not comply with the rules in a free-choice trial, we ended the trial and reminded the participant that he or she must follow the rules the whole time to play for longer. We then presented the next trial.

In all choice baseline sessions, we used moderately and highly preferred activities identified from preference assessment results (e.g., remote-controlled truck, tablet games; see Table 1). In the initial choice baseline probe, which we conducted at least four weeks prior to the next choice baseline session, we used the participants' most-preferred activity as the reward. In subsequent choice baseline sessions, we had participants select an activity from an array of their moderately and highly preferred items at the start of each trial set. We interacted with participants at least once per 10 s of reward access to hold our attention constant across choices and trials.

Across choice baseline, we selected delays for each trial set using a titrating procedure. After each trial set, we either increased or decreased delays based on preference for the LLR or SSR, respectively, to attempt to identify a range of delays within which participants' preference for the LLR reversed. To do this, we conducted a set of trials with a delay of 105 s (i.e., half of the 210 s [3.5 min] delay in the choice baseline probe) with each participant. We planned to decrease delays in subsequent trial sets by half until participants chose the LLR in at least four of five trials, at which point we would increase delays by 50% of the previous delay. We planned to titrate in this manner until consecutive delays were within 10 s of one another. However, we deviated from this procedure a number of times to accommodate participant availability (e.g., if participants were available for only a brief period, we implemented a trial set with brief delays, even if out of sequence) or to ensure a change in direction of titration at least once during choice baseline (excluding Peter and Hank).

Progressive delay training with rule compliance requirement. After conducting choice baseline for a participant, we began PDT. We implemented PDT in the same context and followed the same procedures as in choice baseline with two exceptions. First, both the smaller and larger rewards were available immediately in the first trial set. We increased delays after participants selected the LLR in four of five trials at a given delay. Second, we implemented sessions as frequently as possible, which was typically as frequent as three to five sessions per week per participant. We occasionally conducted more than one session per day for a participant, with a maximum of three sessions in a day for Antonio (once) and two sessions in a day for both Natalie and Mike (once). Session durations varied according to programmed delays. We did not record session durations, but they ranged from under 10 min when delays were very brief (e.g., 15 s) to under 25 min when delays were relatively long (e.g., 120 s). Choice baseline probes (i.e., delays of 180 to 210 s) took approximately 40 min per participant.

In the event that a participant selected the smaller reward in two or more trials in the first trial set (i.e., no delay), we broadened reward options to address satiation. After we broadened reward options for a participant, he or she was able play with any toy or activity throughout the duration chosen (i.e., 30 s [smaller reward] or 60 s [larger reward]). Table 2 contains a list of all activities. Once we established stable responding to the larger reward with no delay, we began PDT. We generally increased delays from zero by 2-3 s after each trial set in which a participant selected the LLR in four of five free-choice trials. When participants selected the SSR in two or more trials at a delay, we returned to the previous delay and repeated a trial set. If they chose the LLR in four of five trials, we increased by half the previous increase and resumed PDT. If the participant did not choose the LLR in four of five trials at the previous delay, we continued to work backwards, two to three previous delays at a time, until we re-established stable responding to the LLR or we made a change to procedures. We made several procedural changes when participants did not respond to PDT (i.e., failed to choose the LLR in four of five trials after we decreased delays three or more times, or when delays were less than 10 s).

Rationale and rule. When a participant did not respond to PDT alone, we modified procedures by providing a rationale and rule about the better choice. We based our decision to add a rule on earlier work demonstrating a rule may be sufficient to increase self-controlled responding (e.g., “it is better to pick the green card;” Benedick & Dixon, 2009). Beyond simply stating a rule, we provided the rationale to facilitate participants’ understanding of both contingencies and potentially promote generalization.

Prior to each set of free-choice trials, we held up either the SSR or LLR card, chosen at random, and asked participants, “When do you have to wait if you choose this one?” and prompted participants as needed until they identified the correct answer (i.e., after [SSR] or before [LLR]). Next we explained, “either way, you have to wait. The big difference is how long you get to play. If you choose this card [held up SSR], you can play for a little bit, but then you have to wait until it’s time to make the next choice. If you choose this card [held up LLR], you wait first, but then you get to play longer. Either way you have to wait, so it is better to wait to play for longer [held up LLR card].” We also described classroom examples of waiting for something the participant might want (i.e., waiting for recess, raising hand and waiting to be called on). After providing the rationale and giving classroom examples of waiting for larger rewards we repeated the rule (i.e., “it is better to wait to play for longer”) a second time. Finally, we said, “Now it is time for you to choose what *you* really want to do” and proceeded to free-choice trials. We did not repeat the rationale, rule, or classroom examples during choice trials. Participants were deemed unresponsive in this condition if they failed to choose the LLR in four of five trials at two or more consecutive delays.

Progressive muscle relaxation. For participants who did not respond in the rationale and rule condition, we added progressive muscle relaxation (PMR) strategy instruction. Intervening activities have been shown to increase the probability of responding to the LLR in several previous studies (e.g., Binder et al., 2000). PMR is an activity in which a person systematically contracts then relaxes isolated muscle groups, and has been proposed as a relaxation strategy that may benefit children with EBD (Lopata, 2003). We selected PMR as an intervening activity because (a) PMR may be used while still completing the rule-following requirement, and (b) we could directly observe whether participants used the strategy during delays or other waiting periods (e.g., after consuming the SSR). We adapted a sequence and script from Lopata, Nida, and Marable (2006) who previously conducted an evaluation of PMR with similar participants to ours (i.e., six- to nine-year-olds with EBD; Lopata, 2003). We also created a visual task analysis to match the PMR sequence (see Figure 1). We displayed the visual task analysis on a green index card. Our PMR strategy included four steps that were to be repeated for each body part included in the sequence (i.e., eyes, nose, mouth, neck, shoulders, arms, hands, whole body). These four steps were (1) squeeze (i.e., contract target muscle group), (2) count to five, (3) relax (i.e., release target muscle group), and (4) count to five again.

To teach the procedure, we first modeled these four steps with two to three isolated body parts. Next, we followed the four steps for one to two body parts along with the participant and provided feedback. After the participant followed along without prompting, we guided the participant through the entire sequence of steps, using the green task analysis card. Once the participant completed these steps along with research staff without prompting, they practiced it independently. During this practice portion of PMR training only, we delivered points for successful completion of all four steps for a body part. Participants exchanged points for stickers at the end of the training session.

Once a participant could independently implement the four steps of the procedure across body parts, we used forced-choice trials to embed PMR strategy implementation into choices of the LLR. In these forced-choice trials, we introduced and prompted students to try a third option, the PMR + LLR card. This card was the same color as the PMR task analysis card (green), and was identical to the LLR card except for color. We reviewed all three cards (i.e., original SSR and LLR cards [white] and PMR + LLR card [green]), provided the rationale and rule from the previous condition, and explained that “sometimes it might be easier to wait if you have something to do while you wait, like use your relaxation strategy.” We delivered forced-choice trials of PMR + LLR with a 10-s delay until the participant independently completed a squeeze/relax sequence with the body part of their choice in three consecutive trials.

Once PMR training was complete, we resumed PDT with the addition of the PMR + LLR option. At the beginning of each session we had participants demonstrate the full PMR sequence during which we provided feedback. After participants demonstrated the strategy, we delivered a forced-choice trial for each of the three choice options in random order. We continued to deliver the rationale and rule and stated, “Sometimes it’s easier to wait when you have something to do, like use your relaxation strategy.” We determined participants unresponsive in the PMR condition when they selected the SSR in two or more of five trials at two or more consecutive delays.

Covert progressive delay training. Next, we modified the original PDT procedure by adapting the language and format of the choice trials. Some participants persisted in choosing the SSR even at very brief delays (e.g., 3 s), and we hypothesized our language about waiting and following the rules may have inhibited their selection of the LLR. Thus, we dropped the language about waiting and following the rules, as well as the forced choice trials. We decided instead to progressively increase delays to the LLR without indicating it in any way, other than implementing delays, to participants. We began the first several trial sets with one to two trials in which both options were immediate (i.e., “would you rather play longer *right now*, or a little bit right now?”) to re-establish preference for the larger reward when no delays were present. For some participants, we had to repeat no-delay choices multiple times before their preference was re-established. We faded the inclusion of initial no-delay trials across subsequent sets.

When we presented trials with delays, instead of presenting the LLR as “play for longer after waiting and following the rules,” we asked simply whether the participant would rather play for a little bit or for longer (i.e., no statement of requirement to wait and follow rules). We then implemented planned delays according to participant choice (i.e., before accessing the activity [LLR] or after accessing the activity [SSR]. Related to this change in language, we did not require participants follow the rules the whole time to play for longer. When participants followed rules for the duration of a delay either prior to the larger reward or following the smaller reward, we delivered praise. When participants broke a rule, we briefly directed them to follow the rules. Other than brief redirects, research staff did not interact with participants during delays.

Progressive delay training with signaled delays. Finally, for participants who did not respond to any of the previous PDT adaptations, we returned to PDT with forced-choice trials but with the addition of signaled delays. Vollmer and colleagues (1999) demonstrated that signaling delays increased self-controlled responding in two young boys with developmental disabilities, and we hoped this adaptation would improve self-control for participants who had been unresponsive to all previous versions of our training procedures. Procedures were exactly the same as in PDT, except in forced- and free-choice trials. We (a) included delay duration in the choice (e.g., “would you rather play for a little bit right now, or for longer after waiting and following the rules *for 5 s*?”) and (b) held the timer in view of the participant and silently counted along by holding up a finger for each s that elapsed.

Procedural Fidelity

A second observer coded procedural fidelity for all trials in which we assessed IOA (i.e., minimum of 66.7% per condition and participant). We used paper and pencil checklists to track choice presentation (i.e., both presented to participant accompanied by the appropriate script for the condition), implementation of delays and access to toys and activities (i.e., within 10% of programmed duration), delivery of programmed praise statements or redirects, and appropriate response to rule violations according to condition (e.g., remind participant to follow the rules [CPDT] or explain to participant what they did to break the rule, end trial, and proceed to next [all other conditions]).

We calculated procedural fidelity by dividing the number of observed steps by the number of programmed steps, which varied across trials according to opportunity and condition. Primary variables coded included appropriate delay durations implemented (i.e., within 10% of delay), appropriate duration of delay following consumption of SSR, SSR, and LLR, appropriate timing of reward delivery and access, abstinence from interaction with participants during delays and inter-trial intervals, and interaction with participant during access to SSR and LLR. Procedural fidelity data are displayed in Table 4. Across participants, fidelity averaged 100% and 99.7% (range, 98.3% to 100%) across participants for the pre-training natural baseline and choice baseline conditions, respectively. Procedural fidelity averaged 99.9% (range, 99.7% to 100%) in the initial PDT condition, 99.8% (range, 99.3% to 100%) in the PDT with contingency descriptions and rule condition, 99.7% (range, 99% to 100%) in the PDT + PMR condition, and 98.9% (range, 97.8% to 99.8%) in the covert PDT conditions. Procedural fidelity averaged 99.6% (range, 98.5% to 100%) in the signaled delay condition (one participant).

Chapter III

Results

Figures 2 through 8 display choice allocation and durations of rule following across choice trials and experimental conditions for each participant. Neither Jerry nor Wayne completed any PDT conditions due to excessive absences and behavior-related transitions and restrictions (see Figure 2), thus we address their respective baseline performances only. In Figures 3 through 8 (i.e., results for participants who completed one or more PDT conditions), the dotted line indicates the point at which we made a larger variety of rewards available during choice trials. We considered an outcome as therapeutic and PDT as relatively effective when delays at which participants selected the LLR in intervention trials exceeded delays at which they selected the LLR during choice baseline. We considered their preference for the LLR at a given delay as stable when they selected the LLR in at least four of five consecutive trials.

Baseline Only

Jerry's choice allocation and duration of rule following during natural baseline and choice baseline conditions are displayed in Figure 2 (left panel). During natural baseline, Jerry waited for a mean duration of 4.2 s. During choice baseline, he chose the SSR in most trials, particularly at relatively long delays. However, he selected the LLR in all five trials at an 11-s delay. Jerry was excluded prior to implementing PDT because the severity and unpredictability of his problem behavior warranted extra staff support to ensure his safety and that of others during regular scheduled classroom activities. Once we concluded PDT with other participants, however, Jerry had refrained from physical aggression for several weeks and we were able to conduct a second set of natural baseline trials. Jerry selected the larger reward in all natural baseline trials, but durations of waiting varied widely (range, 1.29 s to >2 min).

Figure 2 (right panel) displays results for Wayne. Wayne did not complete PDT because he was transferred to a contract school for children with EBD mid-year. Pre-training, Wayne chose the larger reward in three consecutive natural baseline trials, and waited for a mean duration of 20.8 s before stopping the timer. Waiting times decreased across trials. During choice baseline, Wayne sampled the LLR at least once at all but one delay. Wayne selected the LLR more often as delays approached zero. He selected the LLR in every trial in PDT, but did not participate long enough for delay durations to surpass those at which he had selected the LLR in choice baseline. Because Wayne left the school, we were not able to conduct a second set of natural baseline trials.

Responders to PDT with a Rationale and Rule

Of the six participants who completed one or more PDT conditions, none responded to PDT alone. The first adaptation we made to PDT to promote self-controlled responding was to add a rationale and rule about selecting the LLR that we delivered prior to choice trial sets. Three participants were responsive under this condition (i.e., Zac, Mike, and Natalie).

During pre-training natural baseline trials, Zac waited for a mean of 39.5 s. Zac rarely selected the LLR during choice baseline trials. In PDT, Zac preferred the LLR until delays increased to 16 s, at which point he switched to selecting the SSR. We added the rationale and rule and began PDT from 0-s delays after we were unable to re-establish preference for the LLR at lesser delays. Because Zac's transition to a less restrictive placement was impending, we increased delays relatively rapidly once we established that he preferred the LLR at delays exceeding 20 s. Zac's preference for the LLR remained stable until we delivered a final trial set with 90-s delays, at which point he changed preference and selected the SSR in three of five trials. Regardless of his change in preference once delays reached 90 s in duration, PDT with the addition of the rationale and rule was effective at increasing delays at which Zac selected the LLR relative to choice baseline (see Figure 3). Zac transferred to another school mid-year, or we would have continued to implement choice trials and conducted a post-training set of natural baseline trials. However, it should be noted that his transition was to a less restrictive placement because he met criteria to “graduate” from the self-contained school.

Mike’s results are displayed in Figure 4. In pre-training natural baseline trials, Mike waited for a mean duration of 3.3 s. In choice baseline, Mike’s preference for the LLR systematically increased as delays approached zero. Mike was the first participant who received PDT, but he reverted to preferring the SSR across the first three trial sets in which we increased delays proportionally. We repeated PDT procedures, beginning at zero delays, after his preference changed to the SSR at the 20-s delay. When we increased by smaller increments (i.e., 2-3 s), Mike reversed preference from LLR to SSR at even briefer delays (i.e., 16 s).

Despite incorporating new reward options, Mike preferred the SSR when we increased the delay by another few seconds. Thus, we added the rationale and rule to procedures and continued PDT. Mike preferred the LLR at the next delay (i.e., 19 s), but reversed preference again until we delivered trials with briefer delays (i.e., 11 s). We increased delays by two to three seconds across each subsequent trial set, and Mike preferred the LLR until delays increased beyond 31 s. After Mike changed preference, we were able to re-establish his preference for the LLR at briefer delays (i.e., 26 s, 28 s). These results indicate PDT with a rationale and rule was effective at increasing delays at which Mike preferred the LLR relative to delays at which he preferred the LLR in choice baseline (i.e., 13 s). However, Mike refused to attend subsequent sessions after the final trial set with 28-s delays. We were able to conduct post-training natural baseline trials a few weeks later, in which Mike waited for variable durations. Durations of waiting in post-training trials generally exceeded those we observed pre-training.

Natalie waited for relatively long periods during pre-training natural baseline trials (mean, 66.3 s), and often sampled the LLR during choice baseline trials as delays decreased from 210 s. However, Natalie did not initially choose the larger reward when there were no delays to the larger reward, or when delays were increased to 2 s after she met criterion (i.e., selected the larger reward in four of five trials) with no delay. Thus, we offered her additional reward options. In subsequent sessions, she chose to play with the same activities she had before, but often changed activities between trials. Regardless of having new activity options, Natalie did not consistently select the LLR even when delays were as brief as two to three seconds. When we introduced the rationale and rule modification, however, she chose the LLR until delays increased to 11 s, at which point we decreased the delay to attempt to re-establish preference for the LLR. After re-establishing Natalie's preference for the LLR when delays were 5 s in duration, we continued PDT with the rationale and rule for the duration of the study. Natalie continued to prefer the LLR through our last trial set, in which delays were 2 min. Given this increase from delays at which she preferred the LLR in choice baseline (i.e., chose the LLR in three of five trials when delays were 13 s), we consider PDT with the rationale and rule effective for Natalie. In post-training natural baseline trials, however, Natalie waited for less time than she did pre-training, and her waiting times decreased sharply across natural baseline trials.

Inconsistent and Non-responders to PDT

Our remaining three participants (i.e., George, Peter, and Hank), were inconsistently responsive across conditions. We made several additional modifications to PDT in attempts to promote self-controlled choice making among these participants.

George (results displayed in Figure 6) waited for brief periods in natural baseline trials (*M* = 2.6 s) but often sampled the LLR in choice baseline trials. He was somewhat more likely to choose the LLR as delays approached zero, with exceptions (e.g., selected the LLR in three of eight trials in the choice baseline probe). George's preference for the LLR was inconsistent, even when delays were very brief (i.e., 0-4 s), when new rewards became available, and when experimenters provided a description of the contingency and a rule. During the PMR condition, George was more likely to select the LLR as delays increased, and occasionally selected the PMR + LLR option. When he selected the PMR + LLR option, he independently engaged in PMR responses for the [brief] duration of the delay. However, his preference changed when delays reached 9 s and could not be re-established in the PMR condition. Finally, we implemented covert PDT, and he chose the LLR until delays reached 19 s. George typically followed the rules during delays, but when he did not, it was usually because he made a statement to the experimenter who briefly redirected him to follow the rules. Once he changed preference at 19-s delays, we decreased delays once again until he selected the LLR in four of five trials (i.e., 11 s). We continued covert PDT for another few sessions until delays reached 16 s, at which point George's preference reversed. We were unable to re-establish his preference for the LLR in remaining sessions (13- and 7-s delays, respectively). Covert PDT was only temporarily effective at increasing delays at which George selected the LLR relative to baseline (see Figure 6). In post-training natural baseline trials, George waited slightly longer for the larger reward than he did pre-training, although the duration did not exceed any of the delays at which he chose the LLR during intervention.

Figure 7 displays Peter's results. Peter was only temporarily moderately responsive in the PDT alone and covert PDT conditions. Peter selected the larger reward and waited for relatively brief delays in pre-training natural baseline trials (*M* = 2.8 s). He was more likely to select the LLR in choice baseline as delays to the larger reward decreased. In PDT alone, Peter did not initially show preference for the larger reward when there was no delay, so we broadened reward options. However, he did not consistently select the LLR until we provided a rationale and rule. This modification remained in place until delays reached 19 s, at which point he consistently selected the SSR. We could not re-establish Peter's preference for the LLR in this condition. Next, we implemented PMR. Anecdotally, Peter requested a copy of the PMR visual to use during the school day, which we provided. He later reported that a staff member confiscated it. Although Peter verbally indicated a preference for PMR outside of choice trials and occasionally sampled the PMR + LLR choice during trials, this modification was not sufficient for promoting choice of the LLR. During PMR, Peter preferred the SSR even at very brief delays (i.e., 2 s). When he did select the PMR + LLR option, Peter independently engaged in PMR responses for the [brief] duration of the delay. After we determined that PDT + PMR was ineffective for Peter based on his preference for the SSR in consecutive trial sets, we implemented covert PDT. Peter consistently selected the LLR as delays increased, and was more likely to follow the rules during delays as delays increased. However, Peter did not meet criterion when delays reached 18 s, and we were unable to re-establish preference for the LLR even at very brief delays (e.g., 5 s). In post-training natural baseline trials, Peter waited only slightly longer than he did pre-training (i.e., *M* = 2.8 s pre-training and 4 s post-training).

Finally, Hank (see Figure 8) waited for very brief periods in pre-training natural baseline trials (mean, 2.6 s). He rarely selected the LLR in choice baseline trials, even as delays approached zero. In PDT, we introduced new reward options early because both times he chose the SSR in that trial set, he complained that he was tired of playing the games. With new reward options and PDT alone, Hank reliably selected the LLR until delays reached 17 s. After Hank began selecting the SSR with 17 s delays, we were unable to re-establish preference for the LLR at several previous delays. Thus, we introduced the contingency description and rule modification, which did not promote choice of the LLR. Next, we trained Hank to use PMR during delays. Although Hank verbally expressed enjoying the procedure during practice and forced-choice trials and requested additional practice opportunities, he did not select the PMR + LLR option in any free choice trials. After attempting PMR in combination with PDT, we proceeded to the covert PDT condition. Hank preferred the LLR for two consecutive sessions, but reversed preference once delays reached 8 s. He also consistently talked out during delays. At this point, we attempted to re-establish preference for the larger reward when there were no delays, but had to deliver additional trials to do so. Finally, we attempted to signal delays to increase the probability Hank would select the LLR. Hank preferred the LLR when delays were 2 s in duration, but not when they were 4 s in duration, despite repeated sessions. Overall, no variations we made to PDT were sufficient to increase Hank's preference for the LLR. In post-training natural baseline trials, Hank preferred the smaller reward (i.e., four of six trials) but waited for longer than he did pre-training, regardless of whether he chose the smaller or larger reward.

Summary

During pre-training natural baseline trials, participants waited for variable durations before pressing the timer button to indicate they could not wait any longer. Mean durations ranged from 2.6 s (Hank) to 66.3 s (Natalie). During choice baseline, no participants selected the LLR in four of five trials until delays were relatively brief (i.e., 13 s at most; Wayne and Mike).

PDT alone was not effective at significantly increasing or sustaining delays at which any participants who completed at least one PDT condition selected the LLR, and each of these participants underwent one or more modified PDT conditions. Providing a rationale and a rule (i.e., “It is better to wait to play for longer”) was the most effective adaptation of those tested. The rationale and rule increased delays at which three of six participants who received PDT selected the LLR (i.e., Zac, Mike, and Natalie). Delays at which they reliably chose the LLR increased from to 28 s to two min.

Covert PDT was temporarily successful for two participants (i.e., George and Peter), and increased delays at which participants reliably selected the LLR until delays exceeded those in baseline and participants’ preferences reverted to the SSR. We could not re-establish preference for the LLR at previously-mastered delays for either participant. For one participant (i.e., Hank), no procedure, including explicitly signaling delays, increased self-controlled choice-making. Overall, baseline performance was not predictive of response to intervention – both Zac and Hank rarely selected the LLR in baseline, but only Zac responded to treatment. Likewise, both George and Natalie sampled the LLR frequently in baseline, but only Natalie reliably selected the LLR at longer delays than in baseline.

Chapter IV

Discussion

PDT is one approach to treating impulsivity, conceptualized as selecting a SSR at the cost of an LLR. It has been used in isolation (e.g., Schweitzer & Sulzer-Azaroff, 1988) as well as in combination with intervening activities (e.g., Dixon et al., 2003), signaled delays (Vollmer et al., 1999), and “rules” about the best choice (Benedick & Dixon, 2005). These variations on PDT have proven to increase delays at which people with intellectual and developmental disabilities, acquired brain injuries, as well as typically developing children referred for impulsivity choose the LLR (e.g., Dixon et al., 1998, Dixon & Tibbetts, 2009; Schweitzer & Sulzer-Azaroff, 1988; Vollmer et al., 1999). To date, however, children who receive special education services due to their externalizing problem behavior are unrepresented in the PDT literature. This absence is surprising, given that children with EBD may be particularly likely to engage in impulsive behavior (e.g., Eisenberg et al., 2001/2009; Waschbusch, 2002).

In our study, we implemented a number of research-based modifications to PDT to treat the impulsive choice making of first- and second-grade students with EBD. However, providing a rationale and rule was the only modification that improved self-control, and we observed this improvement for three of six participants (i.e., Zac, Mike, and Natalie). Hank, George, and Peter reliably selected the LLR for several trial sets at a time, but never maintained preference for the LLR across time and substantially increasing delays. Relative to other participants, Mike and Peter showed greater sensitivity to increasing delays, each reversing their preference at similar delays across different points in time (i.e., at 13 to 20 s within each of several PDT conditions). In all, participants were resistant to treatment (whether to PDT alone or in subsequent conditions), but responses varied across conditions and participants.

In the sense that response to treatment varied both within and across participants, our findings may be consistent with previous research in which students with or at risk for EBD responded inconsistently to a treatment that has reliably produced therapeutic effects for other populations. For example, Al-Otaiba and Fuchs (2006) evaluated characteristics of "always responsive," "sometimes responsive," and "nonresponsive" participants in a randomized control trial of a reading intervention including 104 public elementary school children. Problem behavior, as measured by the Teacher Report Form of the CBCL, was a major factor in predicting response to intervention (i.e., highly correlated with non-response and moderately correlated with some response). Variability in reading intervention outcomes for children with EBD labels has also been demonstrated (e.g., Barton-Arwood, Wehby, & Falk, 2005; Falk & Wehby, 2001). In fact, Wehby, Falk, Barton-Arwood, Lane, and Cooley (2003) suggested variability in academic performance both within and across participants may be characteristic of EBD, and may be a result of a variety of factors (e.g., ongoing academic struggles, episodic problem behaviors, language ability).

Our choice baseline data also may be consistent with previous research regarding characteristics of children with EBD. Teachers at the school where we recruited first and second-grade participants (i.e., a self-contained school serving children whose problem behavior was unresponsive to supports in less restrictive settings) identified all of their students as impulsive. Most of these students participated in our study (i.e., eight of 10 children enrolled in Grades 1-2). Of these eight, all preferred the SSR in choice baseline (as well as some PDT conditions) except when delays were very brief. These baseline data are consistent with previous literature indicating that children with conduct problems are likely to have co-occurring symptoms of impulsivity (Waschbusch, 2002).

Efficacy of PDT Alone

The co-occurrence of EBD and impulsivity combined with the resistance to treatment we observed among our participants warrant a closer look at how our PDT procedures and results converge with and diverge from those of previous studies. Progressive delay training alone was ineffective, across participants, at maintaining preference for the LLR at increasing delays. Our results differ from those of Schweitzer and Sulzer-Azaroff (1988) who observed therapeutic effects in all five preschool children who participated in PDT. One major difference between the procedures of Schweitzer and Sulzer-Azaroff and ours was our rule-following requirement. Schweitzer and Sulzer-Azaroff did not require participants to engage in (or abstain from) any particular responses during delays. Thus, it is possible the addition of the rule requirement made delays more aversive to participants.

However, our results also differ from those of Dixon and Falcomata (2004), who implemented PDT with a response requirement similar to ours. Dixon and Falcomata required a participant, Ray, to hold his head off his chest and shoulders, and we required participants to sit quietly, keep their hands to themselves, and keep their heads off the table. Dixon and Falcomata did not provide access to any materials or interact with the participant during delays, and neither did we. Dixon and Falcomata demonstrated PDT was effective at increasing delays at which Ray selected the LLR, whereas PDT alone was not effective for any of our participants - even when increments of increasing delays were very brief relative to those in previous studies (e.g., 2 s [this experiment] versus 10 s [Benedick & Dixon, 2009; Dixon & Falcomata, 2004]). While we do not know why our participants did not respond to PDT alone, it is important to note that Dixon and Falcomata did not replicate intervention effects across participants.

Efficacy of PDT with a Rationale and Rule

To learn more about our participants' responses to PDT and identify an adaptation that promoted their self-control, we proceeded to implement a range of research-based modifications. First, we added a rationale and rule to PDT procedures. For adults with dual diagnoses of mental illness and intellectual disabilities, Benedick and Dixon (2009) demonstrated the efficacy of PDT with a rule (i.e., "it is better to pick the [LLR] card") delivered prior to each trial. Surprisingly, the participants in our study who shared more characteristics with those in Benedick and Dixon's study failed to respond to rule conditions. George, Hank, and Peter were the lower-functioning among the six participants who completed our training conditions. Both George and Hank had primary special education labels of Developmental Delay and had significantly lower IQ scores (according to school records) than other participants. Peter was the youngest participant by one year (see Table 1), and both Peter and George had secondary educational labels of Language Impairment (LI). It is possible these participants did not fully understand the rationale and rule presented in this condition.

In contrast, Zac, Mike, and Natalie, who were likely the higher-functioning of the six participants who completed training conditions, consistently selected the LLR across significantly increasing delays when we provided a rationale and rule. All three had average or above average IQ scores, as well as labels of Emotional Disturbance. Mike also had LI and Speech Impairment labels. In our rationale and rule procedures, we told participants, "Now it's time for you to choose what *you* really want to do," after explaining why it was better to wait to play for longer. We did not repeat the rule during trials, rather, we hoped participants' experience with the respective contingencies would be consistent with and confirm the rationale we provided for the better choice. Based on the characteristics they shared, we speculate that Zac, Mike, and Natalie understood the rationale we provided for waiting for the larger reward (i.e., "either way you have to wait, so it is better to wait to play for longer"), or had developed rule-governed behavior to a greater extent prior to or during PDT compared to our other three participants.

Zac's, Mike's, and Natalie's favorable responses under the rationale and rule condition do raise the question of whether it was necessary to progressively increase delays (i.e., implement PDT), or whether the rationale and rule alone set the occasion for self-controlled choices. While our design does not allow us to answer this question directly, we believe that progressively increasing delays, at least to some extent, contributed to participants' preference for the LLR across increasing delays. Both Natalie and Mike reached delays at which their preferences reversed during the rationale and rule condition (see Figures 5 and 6). However, we were able to re-establish preference for the LLR at a previously mastered delay and continue beyond the delay at which their preferences initially changed. As delays increased, Natalie sampled the SSR at regular intervals (i.e., about once per trial set). In other words, she continued to test the SSR contingency despite our rationale and rule about the best choice. This variability in her preference for the LLR, across delays, may also support the notion that PDT was necessary above and beyond the rationale and rule.

Efficacy of PDT with an Intervening Activity

To promote self-control among the three participants for whom the rule and rationale was not sufficient (i.e., George, Peter, and Hank), we added an intervening activity during the delay to the LLR. We identified PMR as an intervening activity that the children could perform while continuing to meet the rule requirement imposed in previous conditions. PMR has been promoted as an activity that increases relaxation and decreases problem behavior among children with EBD, although the evidence is limited (e.g., Lopata, 2003). We required participants to meet mastery criteria for PMR before proceeding to choice trials, and observed them independently engaging in the strategy on the occasions they selected the PMR + LLR option. This rules out a skill deficit as a potential explanation for the failure of the PMR condition to promote self-control.

It is also notable that participants rarely chose to use the strategy despite the brevity of programmed delays. These results suggest that not only did PMR fail to improve self-control, but children preferred to wait silently without engaging in PMR. This is unexpected, given previous literature has demonstrated participants' preference to engage in an intervening activity while waiting for the LLR (e.g., Dixon et al., 2003; Dixon & Cummings, 2001).

However, PMR differs from intervening activities used in previous studies in one primary aspect. While PMR involved no additional stimuli or interaction with others, intervening activities embedded in progressive delay procedures in previous studies involved additional stimuli participants could manipulate or use to interact with other people (e.g., sorting items [Dixon & Holcomb, 2000; Dixon & Tibbetts, 2009], labeling items on flashcards [Binder et al., 2000]). Perhaps providing a more stimulating intervening activity would have increased delays at which our participants selected the LLR. If successful, we could have faded the intervening activity to address our goal of increasing delays at which children would wait quietly for the LLR, following the rules. Gokey and colleagues (2013) used PDT with an intervening activity in an experiment targeting self-control in three children with autism. They faded the intervening activity completely after finishing PDT while maintaining participants' preference for the LLR (with no activity during the delay). Gokey and colleagues' procedure may be worth investigating for its efficacy among children with EBD.

Efficacy of Covert PDT

When it became clear that neither George, Peter, nor Hank preferred the PMR + LLR option, we eliminated it. In its place, we returned to PDT alone and modified it to address the possibility that the language we used about waiting and following rules was inhibiting self-controlled responding. While effects were weak relative to outcomes for Natalie or Zac in the rationale and rule condition, George responded better in the CPDT condition than in any others, reliably selecting the LLR for a greater range of delays. Although we did not require him to follow the rules to access the LLR, he typically did, and was more likely to follow the rules as trial sets proceeded. "Covertly" increasing delays may be a better fit for some participants because it does not include a requirement (although rule-following may be shaped across trials).

Previous research indicates that due to their history of exposure to delayed, unpredictable, or lean schedules of reinforcement, children with EBD may be prone to developing patterns of learned helplessness and may be less likely to elect to engage in a difficult response (Seligman, 1975; Sutherland & Singh, 2004). Perhaps describing the response requirement frames choice of the LLR as a difficult response, and forgoing that language temporarily promotes self-controlled choices for some children with EBD (e.g., George, Peter), while explicitly describing them promotes self-controlled choices for others (e.g., Zac, Mike, and Natalie).

Efficacy of Signaling Delays during PDT

None of the contextual changes we made influenced Hank's preference for the LLR beyond temporary response under the initial PDT alone condition, including signaling delays. Vollmer and colleagues (1999) demonstrated that signaling delays promoted self-control both within and outside the context of progressive delay training, and signaling has long been accepted as a general accommodation for promoting tolerance for delays (e.g., Hagopian et al., 1998; Reichle, Johnson, Monn, & Harris, 2010). Hank was our only participant with a diagnosis of ADHD who underwent training (see Table 1), and perhaps his choices were a function of the severity of his condition. Alternatively, his persistent preference for the SSR could have been a result of the sequence of conditions or the great number of training trials we conducted prior to the signaled delay condition.

Limitations

Our conclusions should be interpreted in light of several limitations. First, our modified changing criterion design was limited in several aspects that would have further strengthened internal validity for Zac, Mike, and Natalie. Namely, we did not vary the size of delay criterion changes for Mike, and we did not revert to a former criterion delay duration at any point during the stepwise progression for any participants. Our design did, however, meet basic requirements in that it included a baseline and involved greater than four stepwise increases in delay after establishing stable levels of both (a) rule following and (b) choice of the LLR (Gast & Ledford, 2014, p. 383-384).

Second, we applied a series of interventions to the same behaviors (i.e., choice and rule following). Thus, a separation of treatments issue prevents us from assuming that any one condition (e.g., rationale and rule) was responsible for the ultimate delays at which respective participants reliably selected the LLR (Wolery, Gast, & Hammond, 2010, p. 335). Relatedly, participants' behavior patterns were subject to potential sequence effects and multitreatment interference (Barlow & Hayes, 1979). Our choice baseline procedures, which involved relatively long delays, may have had a countertherapeutic effect on performance in subsequent conditions (i.e., potential carryover effect). Likewise, the order and number of our treatment conditions may have influenced choice and rule following in either a countertherapeutic or therapeutic direction. This prevents us from concluding that the most recent treatment (e.g., rationale and rule) was responsible for the change in delays at which participants did or did not select the LLR at greater delays relative to baseline (i.e., potential sequence effect).

Finally, we used different rewards in choice baseline than in intervention procedures because participants showed signs of satiation (e.g., requested different activities, stated "I'm sick of playing [game title]"). We indicate the trial at which we began offering additional reward options on each participant graph (see Figures 2 through 8). However, we observed inconsistent preference for the LLR across participants even after adding new rewards, so we do not believe access to new rewards led to a false positive identification of treatment effect (i.e., Type I error).

Implications for Research

The variability in response to PDT across participants, all of whom preferred the SSR under choice baseline conditions, indicates a need for research aimed at identifying for whom PDT and its variations (e.g., PDT with a rationale and rule) are effective among children with EBD. The logic of single case designs typically gives less weight to "status variables" such as gender, chronological age, ethnicity, IQ, and grade level (Gast, 2010, p. 125). Instead, we define inclusion criteria and evaluate external validity based on functional variables, including performance under baseline conditions. We are more confident treatment effects will generalize to other individuals who show similar patterns of behavior under similar baseline conditions (Birnbrauer, 1981). In other words, similar responses under similar baseline conditions should predict similar outcomes under similar intervention conditions. Given this logic, we selected participants for this study based on their performance in choice baseline – by identifying those who preferred the SSR at a variety of delays.

However, our results were so variable and illustrated such resistance to treatment that they undermine the external validity of PDT for treating the impulsivity of someone identified solely by their choice baseline preference. Because all participants met inclusion criteria related to preference for the SSR, other within-participant characteristics were necessarily relevant to the efficacy of PDT. These "other" characteristics, some of which may be more behavioral or response-based (e.g., degree of rule governance; see below) and some of which may be classified as status variables (e.g., age, IQ), may moderate effects of PDT. Such information about characteristics that predict treatment effect may indicate different avenues for treatment.

For example, rule-governed behavior has been proposed as an explanation of favorable effects of video modeling on social responses of children with EBD (Kern et al., 1995; Kern-Dunlap et al., 1992). This also may be a relevant factor in response to being provided with a rationale and rule in PDT, which was the only condition in which participants responded reliably to treatment. Evaluating the extent to which measures of rule-governance correspond with preference for the LLR under our rationale and rule condition may explain, at least in part, why this condition resulted in increases in delays at which some participants selected the LLR but not others. Future research may involve selecting participants based on their tendencies to engage in rule-governed behavior, and comparing the effects of PDT with and without a rationale and rule using a more rigorous experimental design. This may serve as a first step toward identifying a potential predictor of treatment effects.

Given the inconsistency of our results with those found in previous research, we also recommend that additional adaptations of PDT be explored. For example, progressively increasing delays to rewards in the context of typical classroom behavioral supports for children with EBD (e.g., token systems) may be an avenue for treating impulsivity. Both Neef and Lutz (2001) and Reed and Martens (2011) demonstrated that impulsivity predicts a difference in levels of appropriate behavior in conditions of immediate versus delayed rewards. Perhaps delivering relatively immediate rewards for appropriate classroom behavior during instruction, then systematically increasing delays to those rewards (e.g., increasing delays to token-exchange opportunities), would improve self-control. Choice trials such as those we implemented during PDT, or a computerized assessment of preference for SSR versus LLR such as the one used by Neef and Lutz (2001), could be useful as broader or more distal measures of impulsivity and self-control to evaluate effects of classroom intervention.

Another adaptation of PDT may involve embedding discrete choice trials in naturally occurring opportunities throughout the school day (e.g., "Would you rather have one sticker now, or two stickers after we transition safely back to the classroom from P.E.?"). However, relatively preferable intervening activities (e.g., walking down the hallway during the transition) may explain differences in participants' choices between such embedded-trial procedures and our PDT procedures. Relatedly, trials may also be embedded within a digital game. We observed informally that despite choosing to play for less time (i.e., selecting the SSR), participants often chose to wait for an LLR within the context of certain digital games they played during our procedures. As an alternative method of embedding trials into existing (and relatively preferred) activities, we believe a gamified version of PDT may be worth developing and evaluating for its efficacy.

Conclusion

Despite the evidence that PDT is effective for some participant populations, we observed resistance to treatment among our participants with EBD. For three of six participants, providing a rationale and identifying the "better" choice increased the efficacy of PDT. These findings warrant further research aimed at identifying for whom, among children with EBD, variations of PDT are effective at improving self-control. In addition, extensions of PDT, such as embedding progressive delay training into existing classroom routines or preferred activities, should be explored for their efficacy among this population. Ultimately, the inconsistency of our results with previous research highlights the need for more information about moderators of the effects of PDT on the impulsive choices of children prone to severe or persistent problem behavior. Such information may facilitate the design of targeted treatment approaches for children with EBD and impulsivity.

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Table 1

Participant Characteristics

Name	Gender	Age	Grade	Ethnicity	Disability label; *diagnoses*	Full Scale IQ	Meds	Target behaviors in FBA/BIP	Highly and moderately (italicized) preferred items
Jerry	M	7	2	Black	OHI; *ADHD, ODD, DMDD*	84 (DAS-II)	Clonidine, Trazodone, Adderall, Depakote	PA, NC, T	Coloring, *Fruit Ninja*, *truck*, *Subway Surfer*
Wayne	M	7	2	Black	ED *ADHD, ODD r/o DMDD*	-	None	NC, PA, E	Truck, *Arcade Hoops*, *Subway Surfer*
Zac	M	7	2	Black	ED, IG	154 (RIAS)	Risperdal	T, PA, PD	Madden NFL, *NBA Live*, *Arcade Hoops*, *Subway Surfer*
Mike	M	7	2	Black	LI, SI, ED	98 (DAS-II)	Abilify, Tenex	E, PA	Angry Birds, *Tappy Escape*, *Arcade Hoops*, *truck*
Natalie	F	7	2	Black	ED	86 (WISC)	None	NC, E, PA	Shopkins toys, *Barbies*, *Shopkins World*, *Shoppie Dash*
George	M	7	2	White	DD, LI *ADHD, PTSD*	67, 65 (WISC, RIAS)	Guanfacine	VA, PA, E	Truck, *Angry Birds*
Peter	M	6	1	White	OHI, LI *ASD*	91 (SB)	Concerta, Trazodone, Depakote	N, E, PA, VA	Action figures, *truck*, *Tappy Escape*
Hank	M	7	2	Black	DD; *ADHD*	70 (WISC)	Intuniv, Daytrana, Strattera	PD, PA, E, NC	Subway Surfer, *Fruit Ninja*, *Angry Birds*, *Truck*

ED = Emotional Disturbance, OHI = Other Health Impairment, DD = Developmental Delay, LI = Language Impairment, IG = Intellectually Gifted, SI = Speech Impairment, ADHD = Attention Deficit Hyperactivity Disorder, ODD = Oppositional Defiant Disorder, DMDD = Disruptive Mood Dysregulation Disorder, PTSD = Post-traumatic Stress Disorder, ASD = Autism Spectrum Disorder, *DAS-II = Differential Ability Scales II, RIAS = Reynolds Intellectual Assessment Scales, WISC = Weschler Intelligence Scales for Children, S-B = Stanford Binet Intelligence Scales, PA = physical aggression, NC = noncompliance, T = tantrums, VA = verbal aggression, PD = property damage, E = elopement. *Note: DAS-II scores represent General Cognitive Ability, rather than full scale IQ standard scores.

Table 2

Reward Activities

Digital games	Toys
Angry Birds	Barbie Pet Vet
Tappy Escape	Shopkins Cupcake Queen Café
Tappy Run	Batman vs. Superman
Animal Escape	Remote-controlled truck
PBS Kids	Coloring books (Hot Wheels, Avengers, and Frozen) with markers, crayons, colored pencils
Incredibox	
Puppy Spa	
Roblox	
Madden NFL	
NBA Live	
Fruit Ninja	
Arcade Hoops	

Note: Complete list of activities available after new rewards were offered in PDT. Moderately and highly preferred activities for individual participants listed in Table 1.

Table 3

Percentage of Sessions with Interobserver Agreement for Choice Responses and Rule Following

			Progressive Delay Training					
Participant	NB [pre]	CB	Alone	R+R	PMR	CPDT	Signaled	NB [post]
Jerry	100	75	n/a	n/a	n/a	n/a	n/a	50
Wayne	100	88.9	75	n/a	n/a	n/a	n/a	n/a
Zac	100	100	90	100	n/a	n/a	n/a	n/a
Mike	0	83.33	92.85	100	n/a	n/a	n/a	50
Natalie	100	63.67	100	95	n/a	n/a	n/a	100
George	0	90.9	83.33	100	100	100	n/a	0
Peter	100	83.33	83	100	100	100	n/a	100
Hank	100	88.9	93.8	100	100	100	100	100
All	75	85.4	88.3	95	100	100	See Hank	80

Note: IOA for choice responses and rule following was 100% across all participants. NB = Natural baseline, CB = Choice baseline, R+R = Rationale and rule, PMR = Progressive muscle relaxation, and CPDT = Covert PDT.

Table 4

Summary of Procedural Fidelity Scores by Condition

Participant	NB [pre] Mean *% of sessions*	CB Mean (range) *% of sessions*	PDT Mean (range) *% of sessions*	RR Mean (range) *% of sessions*	PMR Mean (range) *% of sessions*	CPDT Mean (range) *% of sessions*	Signaled Mean (range) *% of sessions*	NB [post] Mean (range) *% of sessions*
Jerry	100 - *100*	99.6 (97.78, 100) *75.0*	n/a	n/a	n/a	n/a	n/a	100 - *50*
Wayne	100 - *100*	100 - *88.9*	99.4 (98.33,100) *75*	n/a	n/a	n/a	n/a	n/a
Zac	73.7 - *100*	100 - *100*	100 - *90*	99.3 (97, 100) *100*	n/a	n/a	n/a	n/a
Mike	- *0*	98.9 (94.9, 100) *83.3*	99.7 (97, 100) *92.85*	99.8 (98, 100) *75*	n/a	n/a	n/a	100 - *50*
Natalie	100 - *100*	99.6 (97.44, 100) *63.7*	100 - *100*	99.9 (97,100) *95*	n/a	n/a	n/a	100 - *100*
George	- *0*	99.3 (93.1, 100) *100*	100 - *83.3*	100 - *100*	99 (95, 100) *100*	99 (94.12, 100) *100*	n/a	- *0*
Peter	93.6 - *100*	100 - *100*	100 - *83.3*	99.8 (98, 100) *100*	100 *100*	98.99 (96.9, 100) *100*	n/a	100 - *100*
Hank	94.7 - *100*	99.7 (97.4, 100) *88.9*	99.8 (98.1, 100) *93.75*	99.8 (98, 100) 100	100 *100*	97.8 (96, 100) *100*	99.6 (98.5, 100) *100*	96.4 (92.85,100) *100*
All	93.6 (94.7, 100) *75*	99.6 (98.9, 100) *87.5*	99.8 (99.4, 100) *88.3*	99.7 (99.3, 100) *95*	99.7 (99, 100) *100*	98.9 (97.8, 100) *98.8*	See Hank	99.3 (96.42, 100) *80*

Note: Means represent percentages of steps observed out of total programmed steps. NB = Natural baseline, CB = Choice baseline, PDT = Progressive delay training alone, R+R = Rationale and rule, PMR = Progressive muscle relaxation, and CPDT = Covert PDT.

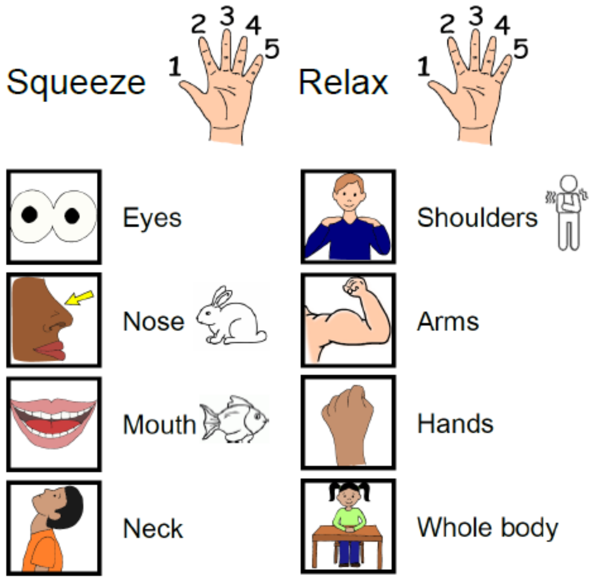

Figure 1. Progressive muscle relaxation visual task analysis. For each body part (e.g., eyes), participants squeezed its associated muscles, counted to five, then relaxed the same muscles and counted to five.

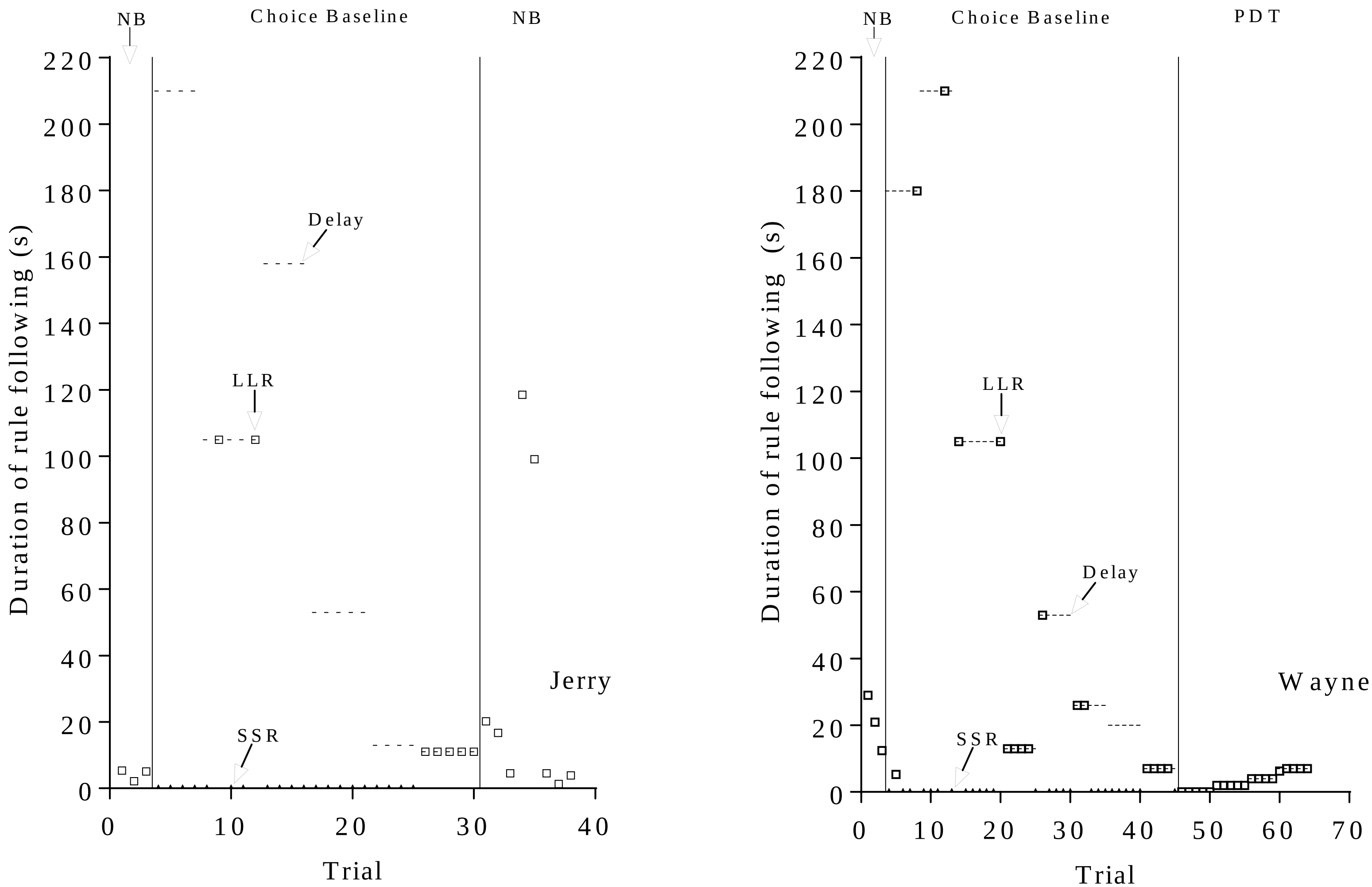

Figure 2. Jerry's (left) and Wayne's (right) choice allocation and duration of rule following across choice trials.

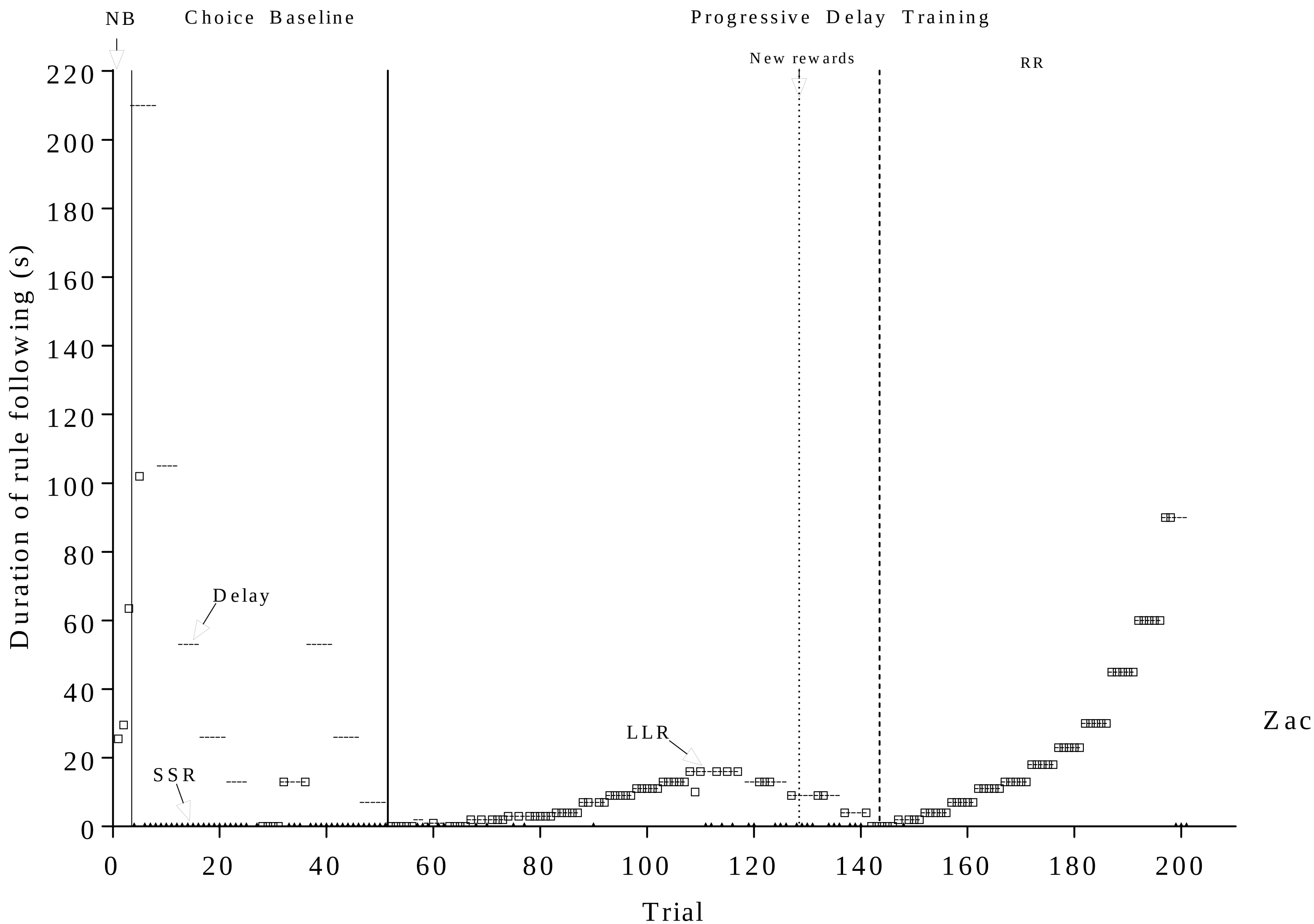

Figure 3. Zac's choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule.

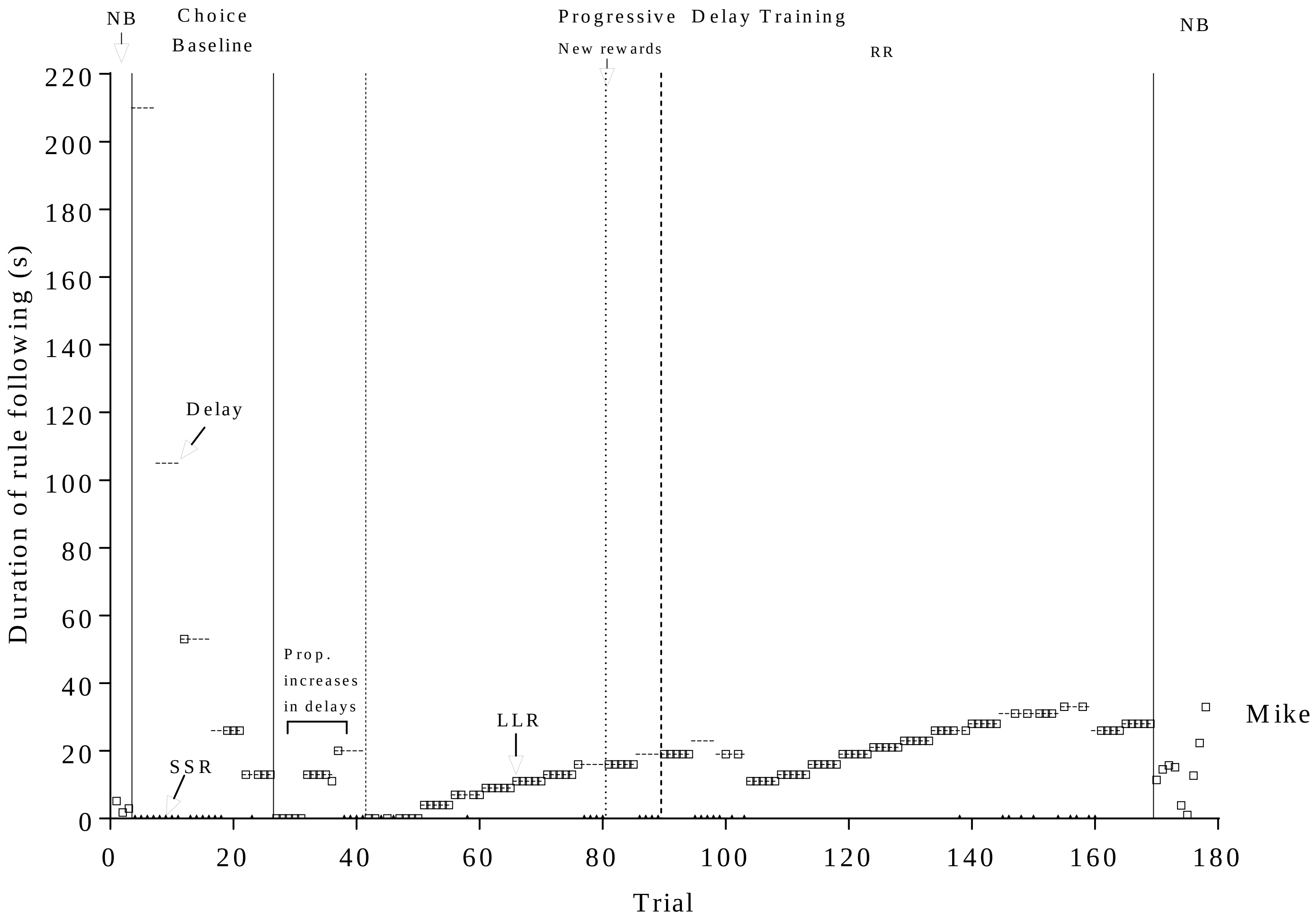

Figure 4. Mike's choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule.

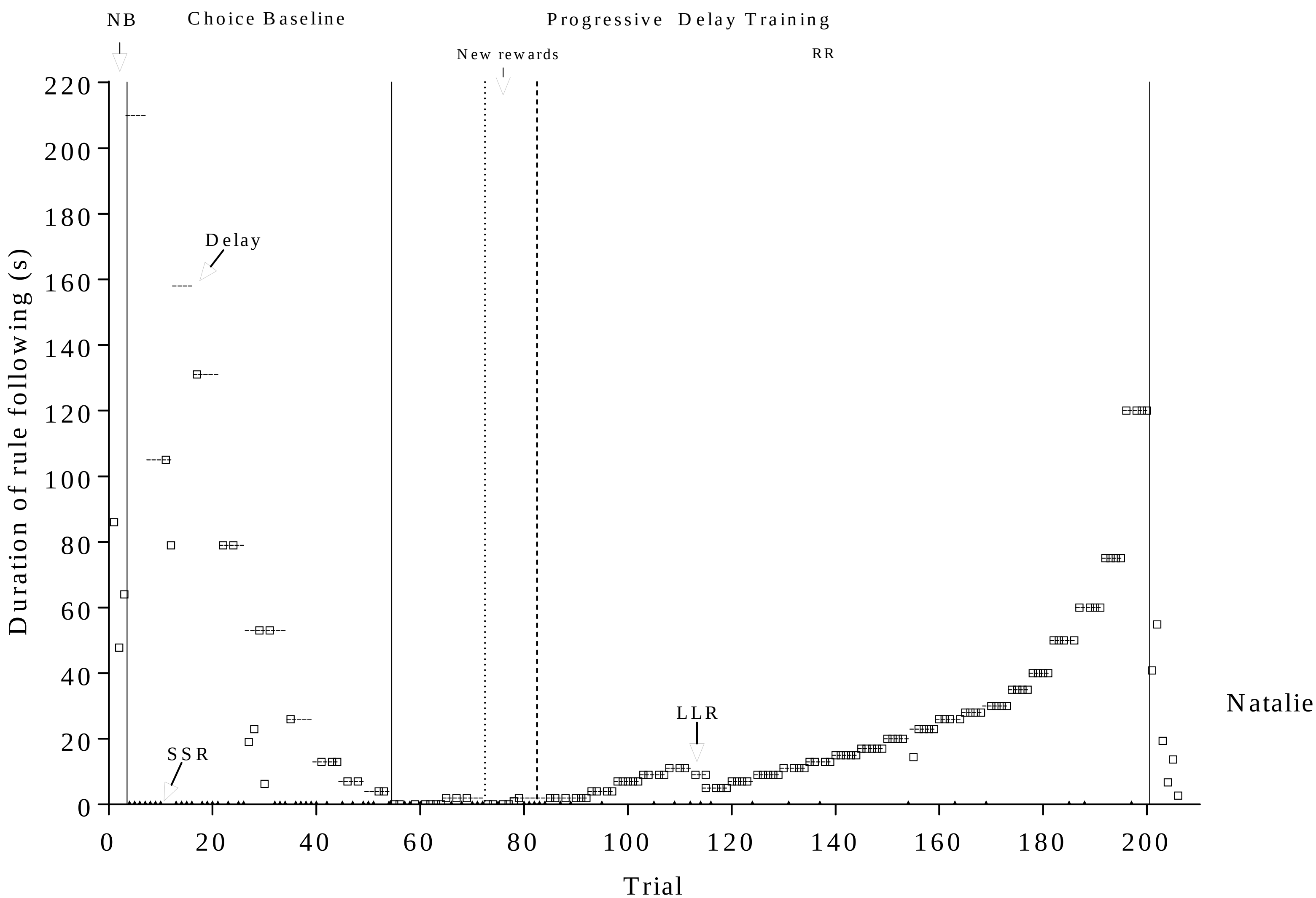

Figure 5. Natalie's choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule.

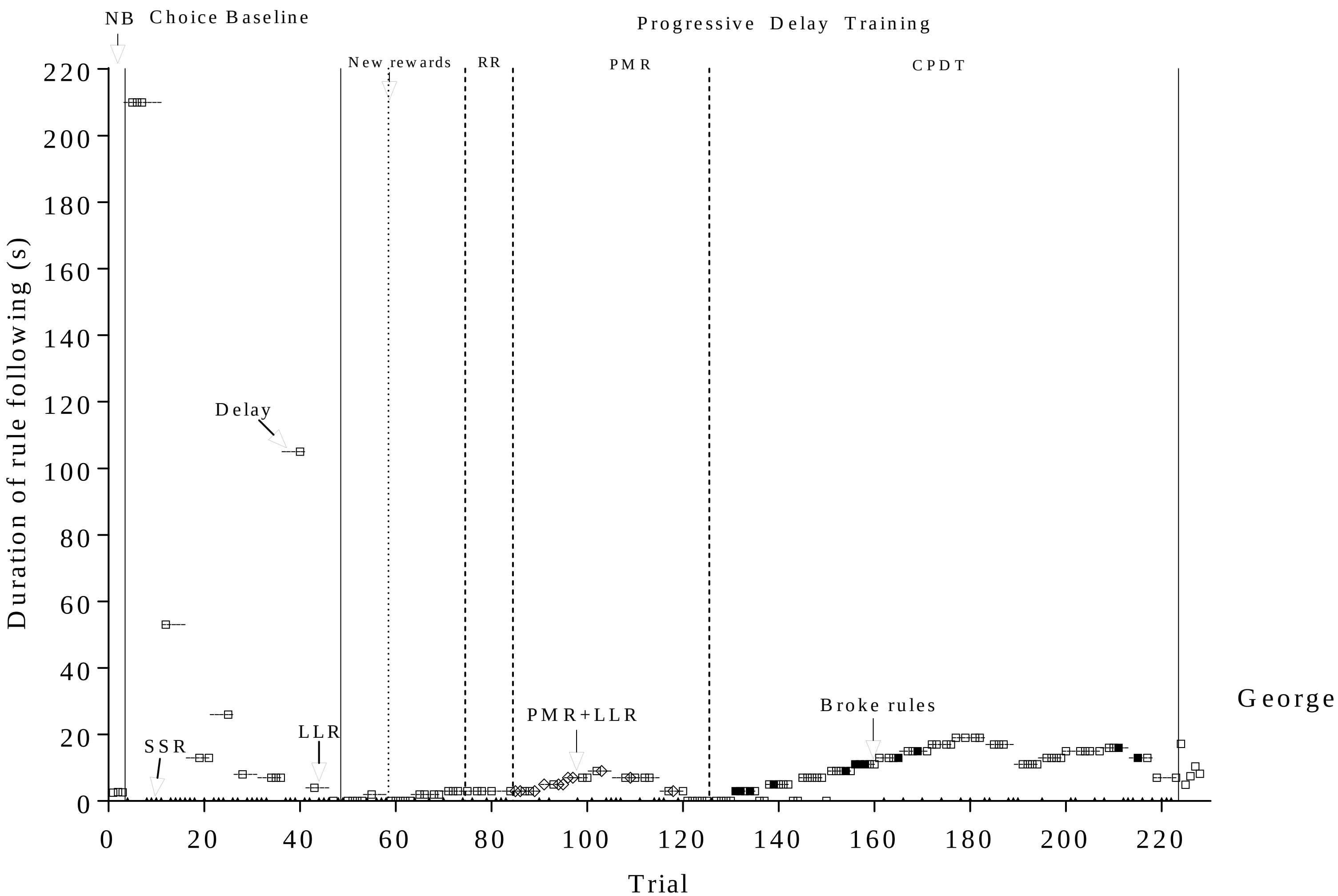

Figure 6. George’s choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule, PMR = progressive muscle relaxation, CPDT = covert progressive delay training.

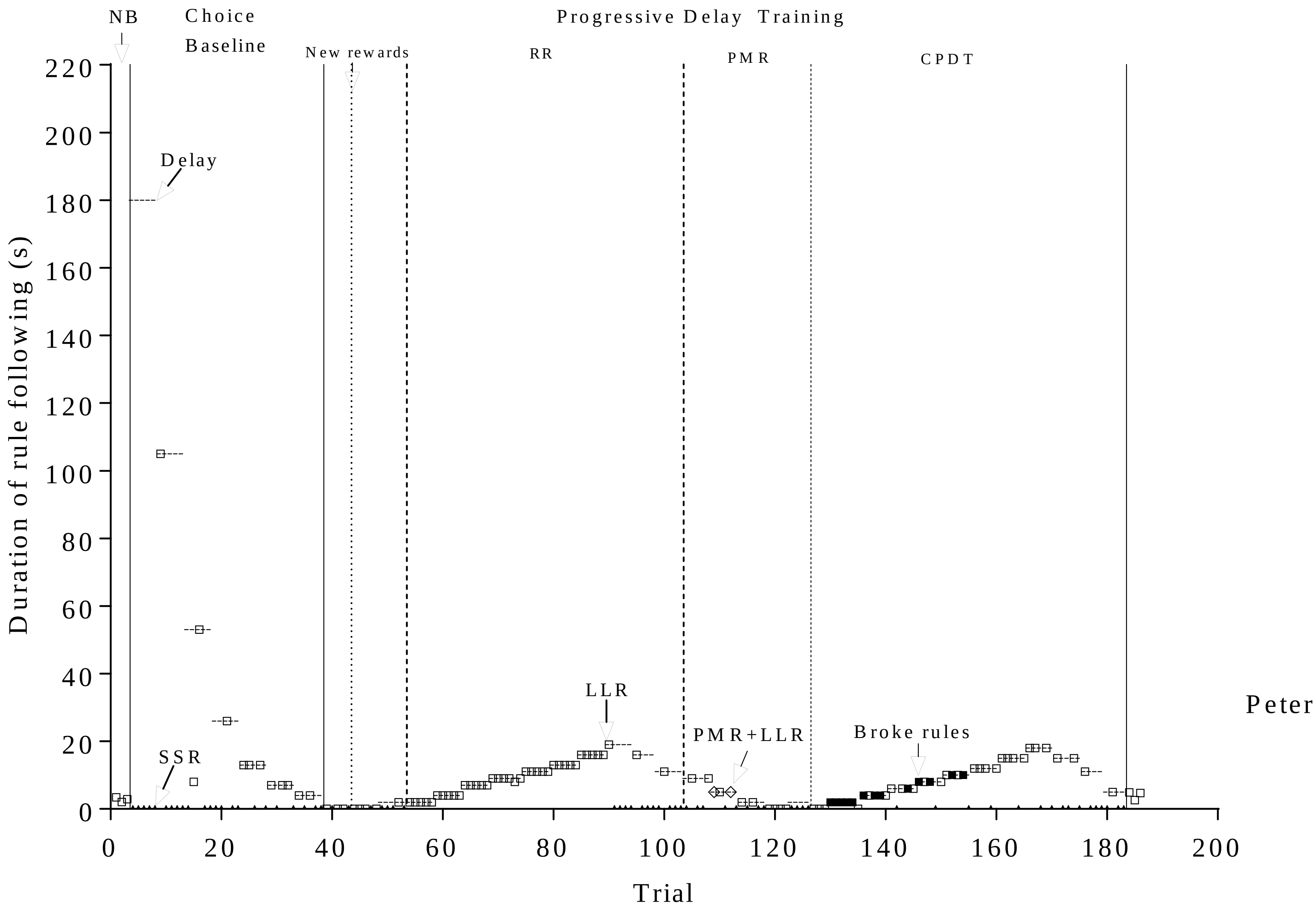

Figure 7. Peter's choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule, PMR = progressive muscle relaxation, CPDT = covert progressive delay training.

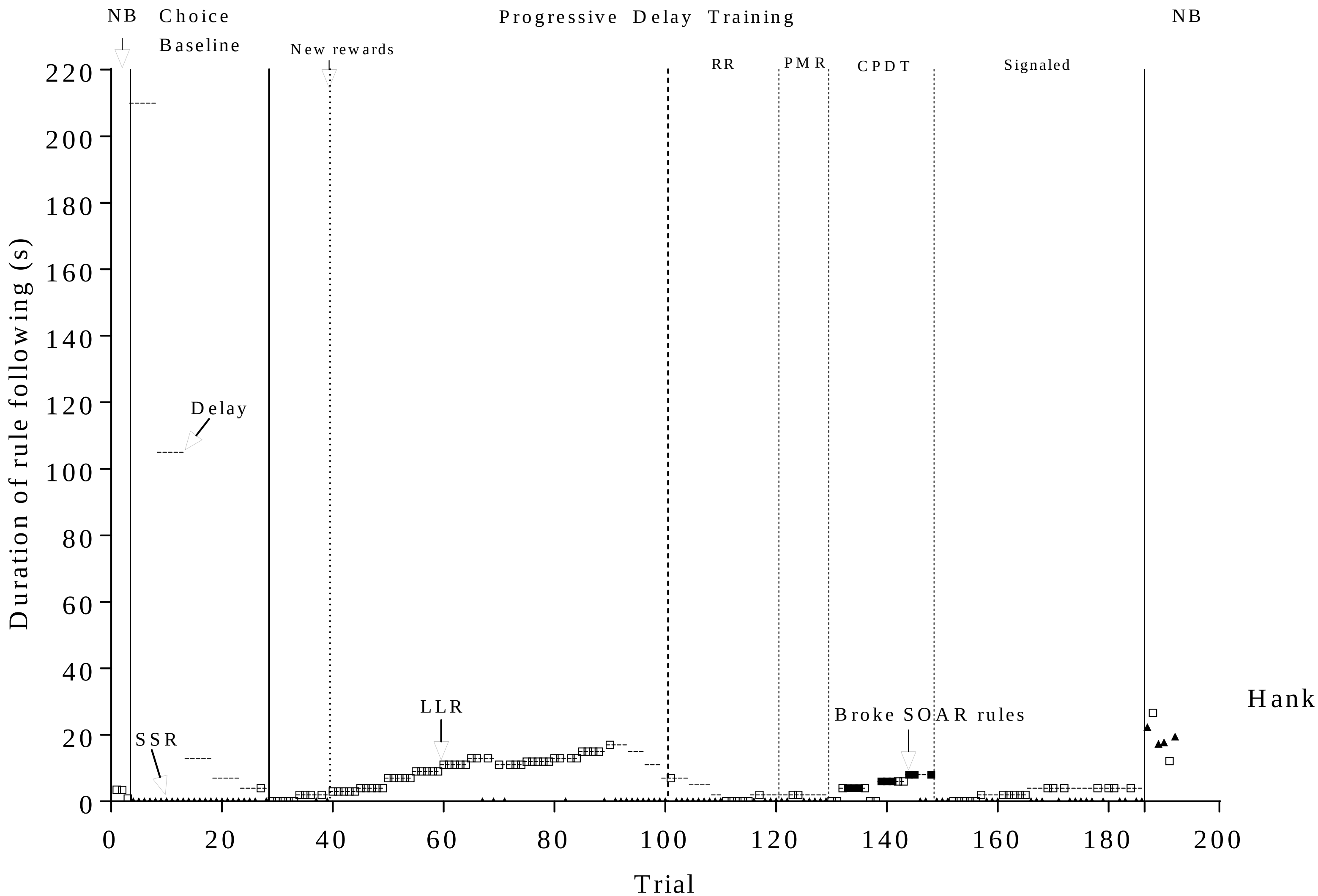

Figure 8. Hank's choice allocation and duration of rule following across choice trials. NB = natural baseline, RR = rationale and rule, PMR = progressive muscle relaxation, CPDT = covert progressive delay training.