Investigating the effects of intervention intensity on skill acquisition and task persistence in children with Down syndrome

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INVESTIGATING THE EFFECTS OF INTERVENTION INTENSITY ON SKILL ACQUISITION AND TASK PERSISTENCE IN CHILDREN WITH DOWN SYNDROME

by

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Abstract

INVESTIGATING THE EFFECTS OF INTERVENTION INTENSITY ON SKILL ACQUISITION AND TASK PERSISTENCE IN CHILDREN WITH DOWN SYNDROME

by

NICOLE MARIE NEIL

Adviser: Professor Emily A. Jones

Maximizing outcomes for learners with Down syndrome requires an approach which is both effective and efficient. Modifying the intensity of intervention has the potential to affect the rate of skill acquisition as well as other learner behavior, such as task persistence, which alters the efficiency of intervention. The purpose of this study was to determine the effect of varying intensity levels of a behavior-analytic on acquisition and task persistence for young children with Down syndrome. Three children with Down syndrome were taught expressive language targets using three manipulations of intervention intensity (dose): the number of opportunities, the spacing of opportunities, and the session duration. We measured the effects of intensity on skill acquisition and task persistence (off-task behavior and affect). Children acquired targets faster in conditions in which the spacing of opportunities was shorter than conditions in which the spacing was longer. Manipulating dose produced individual differences during the different intensity levels in the two measures of task persistence. For two children, moderate intensity levels produced greater expression of positive affect. Children showed idiosyncratic differences in off-task behavior.
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INVESTIGATING THE EFFECTS OF INTERVENTION INTENSITY ON SKILL ACQUISITION AND TASK PERSISTENCE IN CHILDREN WITH DOWN SYNDROME

by

NICOLE MARIE NEIL

To optimally address the needs of individuals with Down syndrome, interventions addressing early weaknesses should be both effective and efficient. This can be accomplished by delivering intervention at an appropriate intensity level. There is growing evidence that applied behavior analytic teaching can effectively address critical areas of weakness (Fidler, 2005) for children with Down syndrome (Bauer, Jones, & Feeley, 2014; Bauer & Jones, 2014a, 2014b; Feeley, Jones, Blackburn, & Bauer, 2011; Jones, Neil, & Feeley, 2013). The approach used in this research is relatively intense, involving structured, teacher-directed learning opportunities, presented in close proximity, with specific prompting procedures, high rates of reinforcement, and error correction procedures. Although there have been advances in demonstrating the effectiveness of this approach for teaching for children with Down syndrome, only recently have researchers begun to identify how to optimize effectiveness by modifying the intensity of this intervention approach.

Intervention intensity refers to the quantity and quality of intervention. Typically, intensity is conceptualized as duration (e.g., Lovaas, 1987). Warren, Fey, and Yoder, (2007) identified parameters using pharmacological framework to expand this conceptualization. Dose refers to the quantitative aspects of intervention within a single session; for example, the length of a session and the number of opportunities within a session. Dose frequency refers to how often those sessions occur and duration refers to the overall length of intervention. Warren et al. also suggest that various combinations of these parameters may be necessary; short sessions delivered
frequently may only need to occur for a few weeks, but long sessions delivered less frequently may require months for individuals to acquire and maintain skills. The quality of intervention, or dose form, refers to aspects of intervention such the complexity of intervention, interventionist skill and experience, and where intervention takes place (Codding & Lane, 2014).

Parameters of dose appear to moderate outcomes during behavior-analytic instruction for individuals with developmental disabilities. In four different studies, correct responding was inversely related to the spacing of teacher-presented instructional opportunities, or inter-trial interval (ITI); that is, closely spaced opportunities produced greater correct responding (Dunlap, Dyer, & Koegel, 1983; Koegel, Dunlap, & Dyer, 1980; Majdalany, Wilder, Greif, Mathisen, & Saini, 2014; Roxburgh & Carbone, 2012).

Dunlap et al. (1983), Koegel et al. (1980), Majdalany et al. (2014) and Roxborough and Carbone (2012) focused on one parameter of dose; ITI. This approach has limitations; when manipulating one parameter of dose the values of other parameters of dose may change. Dunlap et al. (1983), Majdalany et al. (2014) and Koegel et al. (1980) presented an equal number of opportunities using longer and shorter ITIs; in this case, the value of ITI and session duration covary. Roxborough and Carbone (2012) varied the ITI, while holding the session duration constant; thus, ITI and number of opportunities covaried (i.e., were confounded). Manipulating a single parameter of dose does not allow for the isolation of its effects from those of session duration or number of opportunities. Multiple parameters of intensity must be considered concurrently in order to answer the question of how dose affects child outcomes.

Neil and Jones (2014) began to isolate the effects of the spacing of opportunities from the number of opportunities by designing a series of conditions in which the value of one parameter was held constant, while the others varied. In an investigation of the effects of dose in discrete-
trial intervention for receptive communication skills among individuals with Down syndrome, the researchers manipulated three aspects of dose (opportunities per session, session duration, and spacing of session opportunities) and measured skill acquisition of communication targets. The spacing of opportunities had a greater effect than the number of opportunities. For one child number of opportunities varied, but session duration was held constant. The high-intensity intervention (with more opportunities more closely spaced) was associated with faster rates of acquisition than the low-intensity intervention (with fewer opportunities spaced farther apart). For another child, when spacing of opportunities was held constant, but the number of opportunities and session duration varied, there was no difference in sessions to acquisition. This suggested that the spacing may be responsible for the differences in acquisition. In order to determine which of these parameters produced greater change, it is necessary to also compare conditions in which the number of opportunities is held constant and the spacing of opportunities varies.

Identifying appropriate intensity conditions is only one of the challenges of intervention intensity research. Another complication is child characteristics and how those characteristics interact with the parameters intensity. For example, Yoder, Woynaroski, Fey, and Warren (2014) found that dose frequency affected vocabulary acquisition for certain etiologies of intellectual disability. They randomized children with intellectual disability to two dose frequencies of Milieu Communication Teaching: one session per week or five sessions per week over 9 months. They found an effect of intensity on spoken vocabulary for children with Down syndrome while such an effect was not present for children without Down syndrome. Increased dose frequency resulted in greater spoken vocabulary at post-treatment for children with Down syndrome.
For children with Down syndrome the high number of instructional opportunities in intensive interventions are the same conditions that typically evoke off-task or problem behavior. Early in development, children with Down syndrome demonstrate poor task persistence when presented with learning opportunities. Task persistence refers to an individual’s continued effort in overcoming difficulties and is a measure of mastery motivation (i.e., the inherent drive that leads young children to explore and master their environment; Fidler, Hepburn, & Osaki, 2011). This means that in demanding situations, children with Down syndrome are less likely to display task-related behavior, instead, engaging in off-task behavior. Sometimes this may take the form of non-responsiveness; they either do not attend to the instructional stimuli or do not attempt correct responses. In other cases, children may attempt to escape or avoid the task with positive or negative responses (Wishart, 1993). Young children with Down syndrome may refuse to look at task materials, struggle out of chairs, or cry (Fidler, 2006) or use their social strengths to engage or distract the experimenter in efforts to escape from the task (Pitcairn & Wishart, 1994). If children with Down syndrome “opt out” (p. 50) of opportunities for learning new skills, then interventions modified to minimize the impact of poor task persistence will increase the effectiveness of interventions for this population (Wishart, 2001).

Although no studies have measured the effects of intervention dose on off-task or problem behavior among individuals with Down syndrome, Neil and Jones (2014) reported differences in the number of correct responses and, anecdotally, noted differences in problem and off-task behavior as a function of the dose of intervention. There is also evidence that modifying the intervention dosage can increase or decrease problem behavior among populations of children without Down syndrome (Biederman, Stepaniuk, Davey, Raven, & Ahn, 1999; Carnine, 1976; Roxburgh & Carbone, 2012). Thus, there may be some optimal dosage of intervention at
which children with Down syndrome both acquire skills and display high levels of task persistence. Warren and Yoder (2007) even suggested that the correct intervention intensity may teach task persistence as a side effect of intervention.

The purpose of this study was to conduct a systematic manipulation of dose on skill acquisition and task persistence during discrete-trial instruction for communication responses in children diagnosed with Down syndrome. We compared the effects of three parameters of dose (number of opportunities, spacing of opportunities, and session duration) on skill acquisition and task persistence using alternating treatment designs.
Method

Participants

Three children with Down syndrome between 2 and 5 years of age participated. Two participants were female and one was male. Table 1 summarizes pre-intervention characteristics of each participant. Participants were recruited via a listserv from a local Down syndrome advocacy organization. This study was approved by the CUNY Institutional Review Board and parents provided informed consent for participation.

Setting and Interventionist

Inervention took place in participants’ homes. Children were seated in a booster seat on a chair at a table or on seated on the floor. The interventionists sat opposite the child in all cases. Task materials were laid out on the floor or the table next to the interventionists. A video camera was also set up on a tripod next to the instructional area to record each session. The interventionist (author) was a graduate student in behavior analysis, holding BCBA certification.

Materials

The interventionist recorded all sessions for coding the frequency of target behaviors, intervention integrity, and interobserver agreement using pens/pencils and datasheets. All random allocation was done using an online random number generator (Urbaniak & Plous, 2013).

Prior to intervention, participants were evaluated using the Mullen Scales of Early Learning (MSEL; Mullen, 1995), the Vineland Adaptive Behavior Scales (Vineland-II; Sparrow, Cicchetti, & Balla, 2005), and the MacArthur Communicative Development Inventory (Fenson, Marchman, Thal, Dale & Reznick, 2007).

The MSEL (Mullen, 1995) are a measure of intelligence used with individuals from birth to 68 months. The test generates six age-normed scores: an Early Learning Composite Score, the

The Vineland-II (Sparrow et al., 2005) evaluate adaptive functioning in four domains: Communication, Daily Living Skills, Socialization, and Motor Skills. This study used the “Parent/Caregiver Rating Form” which is administered as a parent/caregiver-report questionnaire where each item on the Vineland-II is rated 0 (no, never), 1 (sometimes or partially), 2 (yes, usually), or DK (don’t know), although some items may be rated N (no opportunity).

MacArthur-Bates Communicative Development Inventories (CDI; Fenson et al., 2007) is a standardized parent report measure that assesses a child’s gestures, vocabulary, and grammar when these aspects of language and communication first emerge. The "Gestures and Words" form consists of a list of 408 words, divided into 19 categories that include nouns, verbs, and function words (e.g., articles, pronouns, prepositions) and a list of 63 gestures and actions, also grouped into categories (e.g., deictic and representational gestures, pretend actions, routines). For words, parents mark those that the child understands and/or produces. For gestures, parents indicate whether the child produces a particular gesture or action.

A list of preferred items to deliver as reinforcement was determined using the Reinforcement Assessment for Individuals with Severe Disabilities (RAISD; Fischer et al. 1996). The RAISD is a structured caregiver interview that asks parents to identify and rank potential reinforcers in order of preference. Preferred items were validated via a multiple stimulus without replacement preference assessment prior to intervention sessions.
**Design**

Three levels (high, moderate, and low intensity) of three different manipulations of dose (number of opportunities, interstimulus interval [ISI], and session duration held constant), totaling 9 conditions, were examined using alternating treatments designs. Table 2 details the number of opportunities per session, interstimulus interval, and session duration for each of the intervention conditions.

**Response Measurement**

**Skill acquisition.** The interventionist recorded child performance on intraverbal responses during sessions on data sheets. On each opportunity the interventionist delivered the discriminative stimulus (SD) (specific targets are listed in Table 3). The interventionist marked an independent correct response when the child produced the target response within 3 s of the SD. She recorded a prompted response if the child produced the target response after the SD that also included a prompt (described shortly). An incorrect response was recorded when the child either did not produce the target response or produced a response other than that identified as the target response.

We measured three summative acquisition outcomes: opportunities to mastery, time to mastery, and percentage correct responding. The child achieved mastery when he or she emitted independent correct responses during 3 consecutive opportunities within a session followed by a correct probe presented the following session. Opportunities to mastery were the sum of the opportunities presented prior to the child meeting mastery criteria. Time to mastery was calculated by multiplying the ISI for the condition by the total number of opportunities to master a skill. Percentage correct responding was the number of the correct responses throughout intervention (prompted and independent) divided by the sum of the correct (prompted and
independent) and incorrect responses during intervention. These were calculated for each target following intervention when the child demonstrated performance of a behavior at a level of mastery.

**Task persistence.**

**Task directed behavior.** Trained undergraduate observers recorded whether the child was on-task or off-task from video recordings of the sessions using a 10-s momentary time sampling procedure. Observers recorded on-task and off-task behavior when opportunities were being presented and during the ISI. On-task behavior was defined as sitting on the floor or seat, oriented toward the teacher or materials, following or attempting the interventionist’s directives, or seeking help in an appropriate manner (e.g., raising hand). Off-task behavior was defined as pausing, looking around, engaging in irrelevant activities with the materials or problem behavior. Problem behavior included aggression (e.g., kicking, hitting, throwing objects) and disruptive behaviors (e.g., talking out, being out of chair, making noise, playing with objects, making faces, behaviors that interfere with task completion). Blocked instances of problem behavior were recorded.

**Positive and negative affect.** Trained undergraduate observers recorded whether the child displayed positive or negative/neutral affect using a 10-s partial interval recording procedure. Observers recorded positive affect when opportunities were being presented and during the ISI. Positive affect was coded if the child smiled or laughed during the interval, and negative affect was coded if the child cried or whined during the interval, or verbalized fear, unhappiness, or pain. Neutral affect was coded if the child displayed neither positive nor negative affect.

**Interobserver agreement.** To examine interobserver agreement (IOA) for children’s acquisition performance during baseline and intervention, a trained undergraduate observer
independently scored each child’s performance on each opportunity. During interobserver reliability training sessions, the interventionist provided the observer with written definitions of target responses. The observer scored video recordings of sessions not used to examine IOA. She was required to achieve 90% agreement with the interventionist on two recordings prior to conducting IOA for this study. The observer scored 36% of James’, 35% of Alice’s and 25% of Claire’s recordings. Agreements occurred when the observer and the interventionist scored the child’s response in the same way. Percent agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100. Overall, IOA across acquisition responses was 99% (93–100%) for James, 97% (88–100 %) for Alice, and 97% (83–100%) for Claire.

Two trained (in the same manner as for acquisition) undergraduate observers coded the task persistence and affect from video recordings for the same 36% of James’, 35% of Alice’s and 25% of Claire’s sessions. IOA was calculated by dividing the number of intervals with agreement (e.g., both data collectors scored the presence of off-task behavior for the interval) by the total number of intervals (i.e., agreements plus disagreements), then multiplying by 100 to convert into a percentage. Overall, IOA for affect was 81% (80- 100%) for James, 87% (74%-94%) for Alice, and 87% (80 - 100%) for Claire. IOA for off-task behavior was 99% (87-100%) for James, 98% (96-100%) for Alice, and 98% (98 - 100%) for Claire.

Procedures

Pre-assessment and target selection. In a single session, the interventionist obtained consent and conducted the MSEL (Mullen, 1995) with the child. Parents completed the Vineland-II (Sparrow et al., 2005) and the MacArthur CDI (Fenson et al., 2007) during this time.
Parents also completed Reinforcement Assessment for Individuals with Severe Disabilities (RAISD; Fischer et al. 1996).

For each alternating treatment design, we identified three intraverbal targets. Targets were tailored to the child according to current areas of need based upon pre-assessments including the MSEL (Mullen, 1995) and MacArthur CDI (Fenson et al., 2007). Alice and Claire were taught responses to social questions (e.g., “What is your name?”) and John was taught intraverbal opposites (e.g., “What is the opposite of hot?”). Targets are listed in Table 3.

In order to ensure that targets were matched on difficulty within participants, the interventionist rated each target response on the presence of several formal characteristics: the typical time at which the sounds enter a child’s repertoire, the number of syllables, and complexity of syllable shapes (e.g., CCV, CVV). According to Sander (1972), later-developing sounds include: /l/, /r/, /s/, /z/, /sh/, /ch/, /j/, /v/, and /th/. The earliest developing sounds include: /p/, /m/, /h/, /n/, /w/, /b/ followed by /k/, /g/, /t/, /ng/, /f/ and /y/. For example, the target response, “weak” was ranked lowest in difficulty for John because the word contains one syllable, no complex syllable shapes, and no later developing sounds. “Dirty” was ranked as most difficult because the word contains two syllables, later developing sounds (e.g., /r/), and complex syllable shapes. Targets were ordered from most to least difficult, and the targets of similar difficulty were placed in groups of three. Each group of three matched targets was randomized, using an online random number generator, to one of the three manipulations. The three targets were subsequently randomized, using the same random number generator, to the different intensity levels (high, moderate, or low) within each alternating treatment design.

**Baseline.** Baseline sessions consisted of 6 opportunities spaced 5 min apart that occurred during a 30 min session. This represented a dose that did not mirror any of the intervention
conditions examined in this study. Each participant completed two baseline sessions. During each baseline opportunity, the interventionist presented the antecedent verbal stimulus and provided the child with a 3-s interval to produce the response. Following a correct response, no response, or other response, the interventionists did not deliver any feedback to the child. Targets were presented in a pre-determined randomized order.

**Intervention.**

**Dose Frequency and Form.** Dose frequency and form were held constant across levels of the independent variable. Dose-frequency was 1 to 3 times per week, depending on the child’s schedule, for all dose manipulations. Dose form was a discrete-trial teaching format. The interventionist and child sat across from each other on the floor or at a table and the interventionist presented structured opportunities for the child to respond. At the beginning of each session, preference for items identified on the RAISD was assessed using a multiple-stimulus without replacement preference assessment. The interventionist used most-to-least prompt fading hierarchy and 3-s time delay. To prompt correct responses, she used a full verbal model with a visual cue (a cue card with the response written) faded to a partial verbal model and a visual cue. During time delay, the interventionist waited 3 s for the child to respond independently after presenting the \( S^D \). If the child did not respond independently following the 3-s delay, the interventionist administered the partial prompt. Prompts were faded using a within-session prompt fading hierarchy (Neil & Jones, 2014). The child achieved mastery when he or she emitted independent correct responses during 3 consecutive opportunities within a session followed by a correct probe presented the following session. Intervention for each target stopped when the child met mastery criteria.
Correct responses resulted in the delivery of high-quality social interactions (e.g., social praise) and tangible items identified by multiple-stimulus without replacement preference assessments conducted at the beginning of sessions and the RAISD. Incorrect responses resulted in the delivery of feedback; the interventionist said, “Uh uh,” and turned her face away from the child for 1–3 s. The interventionist blocked all instances of problem behavior and used least-to-most prompting to redirect the child to the task. When opportunities were not being presented and reinforcement was not being delivered, instructors engaged participants in an activity (e.g., playing with blocks, completing puzzles) that the interventionist and parents identified as not highly preferred. These activities were presented independent of performance during opportunities.

**Dose Manipulations.** Three dose parameters were manipulated; the number of opportunities, ISI, and session duration (Table 2). Each manipulation consisted of three levels of intensity; low, moderate, and high intensity. In each condition, one parameter was held constant, while two were varied. In the condition where the number of opportunities was held constant, 5 opportunities were presented at ISIs of 30 s, 1 min, or 2 min (ISI) for session durations of 2.5, 5, and 10 min, respectively. Inter-stimulus interval refers to the time between presentations of SD (in this study, the time between the presentations of opportunities). In the manipulation where ISI was held constant, opportunities were presented at ISIs of 30 s for 2, 5 or 10 opportunities for session durations of 2.5, 5, and 5 min, respectively. For example, 30 s after the teacher asked, “What’s your name?” she presented the next opportunity. This would occur 2, 5, or 10 times per session according to which of the three experimental conditions was in place. In the condition where session duration was held constant, the interventionist presented 2, 5 or 10 opportunities
for a session duration of 10 min; the opportunities were presented at ISIs of 5 min, 2 min, or 1 min, respectively.

Intervention targets (Table 3) were randomly assigned (as described in the target selection section) to one of the nine conditions (Table 2). Manipulations (number of opportunities, ISI, and session duration held constant) were presented one at a time for each child; when the child mastered the targets assigned to each of the levels of intensity he/she began the next manipulation. The order of manipulations was determined using a random number generator. An intervention session consisted of presenting all three intensity levels (high, moderate, and low) one time. Within each session, intensity levels were presented in randomized order.

**Intervention Integrity.** A trained undergraduate observer scored 36% of James’, 35% of Alice’s and 25% of Claire’s recordings of intervention for the accurate presentation of each of the three components of intervention (i.e., presentation of opportunities, prompting procedure, and provision of appropriate consequences) on each opportunity and adherence to the dose of intervention in terms of number of opportunities, spacing, and session duration. The number of times the interventionist correctly presented the intervention component was divided by the total number of correct plus incorrect presentations of that component, multiplied by 100, to obtain the percentage of correctly implemented intervention procedures. Across both children, intervention integrity averaged 97% (98% for high intensity, 99% for moderate intensity and 94% for low intensity) for the correct presentation of opportunities, prompting procedures, and delivery of reinforcement. Intervention integrity for the intensity levels (shown in Table 2) included the observer’s calculation of the mean session duration, ISI, and number of opportunities.
**Generalization.** To determine the relationship between dose and generalization of communication targets, generalization probes across novel people were administered post-mastery. For all three children, generalization was conducted with a direct caregiver. Each generalization session consisted of 6 opportunities presented 5 min apart (as in baseline) presented in the same manner as baseline opportunities. Sessions were conducted after the last session of intervention for all targets.
Results

Skill Acquisition

Figure 1 shows the three summative acquisition measures. The total number of opportunities to master each target (top row of panels), the total minutes to master each target (middle row of panels), and percentage of correct responses during intervention for each target (bottom row of panels) for all participants during all three manipulations: ISI held constant (left column), duration held constant (middle column) and opportunities held constant (right column). Children are represented by different markers: circles, triangles, and x’s for Alice, John, and Claire, respectively. Table 4 presents the mean opportunities to mastery and minutes to mastery for each child across levels of the independent variables.

Two measures of the acquisition rate included the number of opportunities and time to mastery, shown in the top two rows of Figure 1. When the interstimulus interval was held constant (left column), children took similar numbers of opportunities and minutes to master targets across low, moderate, and high intensity levels. For Alice and John, all three intensities produced similar opportunities and time to mastery, as shown in the top and middle graphs. Claire showed an increase in the number of opportunities to master as a function of intensity, with the low intensity condition requiring 16 opportunities and 8 min to mastery while the high intensity condition required 34 opportunities and 17 min before mastery.

When session duration was held constant (middle column), there was an increase in the number of opportunities to master targets as a function of intensity (top panel): ranging from 9 to 13 opportunities in the low intensity condition and 14 to 34 opportunities in the high intensity condition. Opportunities to mastery, however, is a measure of learning that provides a comparison of the effects of intervention without regard to the time required to complete an
intervention session. Time to complete intervention varied because the spacing of opportunities varied across intensities. Shown in the middle graph, there was a decreasing time to master targets as a function of intensity for all three children. Although children took the greatest number of opportunities to master targets in the highest level of intensity, children took the least amount of time to master (7 to 34 min) the targets compared to the low and moderate intensity conditions.

When the number of opportunities was held constant (right), it took children similar numbers of opportunities (top panel) to master targets across the three intensity levels as indicated by the stable trends though there were individual differences in the number of opportunities required to master skills: for John, 9 to 13 opportunities; Claire, 9 to 18; and Alice, 29 to 40. As when session duration was held constant, the spacing of the opportunities varied when the number of the opportunities was held constant. The middle graph indicates the minutes to mastery for each child. Children showed decreasing minutes to master skills as a function of intensity; low intensity conditions produced the longest acquisition times (22.5 to 100 min) and high intensity conditions produced the shortest acquisition time (4.5 to 19 min).

Across all three manipulations, the highest intensity conditions required the fewest minutes to master each skill, despite generally requiring greater numbers of opportunities to master the skill (Table 4). The spacing of the opportunities produced the greatest effect in rates of acquisition; the differences in minutes to mastery were greatest for the manipulations where session duration and opportunities were held constant and minutes to mastery similar across levels of intensity in the interstimulus interval held constant manipulation.

Another variable of interest is the quality of acquisition across the varying intensities; percentage of correct responding and generalization. The bottom panels of Figure 1 show the
percentage of correct responses (with and without prompts) for each manipulation. Correct responding was similar across all manipulations and levels of intensity ranging between 65% and 100%. Children generalized responses to their caregivers and the mean generalization performance for all three children is presented in Table 4. When the interstimulus interval was held constant, the high intensity condition produced the highest levels of generalization and there was a decreasing trend as the intensity decreased. When the session duration and number of opportunities were held constant, the differing levels of intensity produced similar levels of generalization. Thus, high intensity conditions maximized both acquisition and generalization to parents.

**Task Persistence**

We measured two indicators of task persistence: off-task behavior and affect. Figures 2-7 show the cumulative responses across 10-s intervals for positive affect and off-task behavior during low, moderate, and high intensity conditions across all manipulations. Each graph displays the cumulative responses for the entire duration of each condition. Recall that once a child mastered a target at a level of intensity, intervention at that level for that targeted ceased. We focus on the period of time when all three conditions are in place (before the child mastered his/her first target within a condition), because this is when experimental control for the alternating treatment designs is demonstrated. Changes in rate following this period of time are noted.

For John, positive affect (Figure 2) occurred at the highest rates during the moderate intensity conditions for all three manipulations; the steepest functions were obtained under the moderate condition for all three intensity manipulations. In the constant ISI condition (top panel), the first target John mastered was “quiet” in the moderate intensity condition. At this
point in intervention (22 intervals after the onset of intervention), his cumulative level of positive affect responses was 14. For the low- and high-intensity conditions, the levels were 8 and 7, respectively. In the constant duration condition (middle panel), the first target John mastered was “old” under the high intensity condition. At this point in intervention (85 intervals after the onset of intervention), the cumulative level of positive affect responses were 27, 42, and 26 in the low, moderate, and high intensity condition, respectively. In the constant opportunities condition (bottom panel), the first target John mastered was “left” under the high intensity condition. At this point in intervention (29 intervals after the onset of intervention), the cumulative level of positive affect responses was 11, 16, and 8 in the low, moderate, and high intensity condition, respectively.

There was no differentiation in the rate of off-task behavior (Figure 3) across the three intensity levels during the all three intensity manipulations. John displayed very low frequencies of off-task behavior; his cumulative level of off-task responses was between 0 and 3 at the point when intervention ended for the first target in all of these manipulations. In the constant opportunities condition, when intervention terminated for the first target mastered, “left,” under the high intensity condition (29 intervals after the onset of intervention), and the second target mastered, “dark,” under the moderate intensity condition (43 intervals after the onset of intervention), the rate of off-task behavior began increasing in the low intensity condition (at 67 intervals after the onset of intervention) and continued at this higher rate until intervention ended upon mastery.

For Alice, in general, positive affect (Figure 4) occurred at the highest rate during the moderate intensity conditions. During the constant ISI condition (top panel), the first target mastered was “what school do you go to?” in the high intensity condition. At this point in
intervention (52 intervals after the onset of intervention), the cumulative frequency of positive affect responses were 14, 18, and 8 positive affect responses in the low, moderate, and high intensity condition, respectively. During the constant duration condition (middle panel), the first target Alice mastered was “what are your brother’s names?” in the moderate intensity condition. At this point in intervention (80 intervals after the onset of intervention) the cumulative frequency of positive affect responses was 9, 13, and 10 in the low, moderate, and high intensity condition, respectively. Just prior to intervention ending for the moderate intensity target (70 intervals after the onset of intervention), the slope of the low and high intensity conditions increased and Alice maintained this higher rate of responding in both conditions until 150 intervals into intervention, where responding stopped in the high intensity condition. In the constant opportunities condition, the slopes for all three intensity levels are similar until the 60th interval, where positive affect rates in the moderate intensity level increased. The first target Alice mastered was “how old are you” in the high intensity condition. At this point in intervention (146 intervals after the onset of intervention) the cumulative frequency of positive affect responses was 30, 40, and 39 in the low, moderate, and high intensity condition, respectively.

Alice’s rate of off-task behavior (Figure 5) was similar across low, moderate, and high intensity levels when the ISI was held constant; the slopes of off-task behavior in all three intensity conditions are relatively shallow and unchanging. The high intensity condition produced no off-task behavior. In the constant duration condition, off-task behavior occurred at the highest rate during the low intensity condition. The first target Alice mastered was “what are your brother’s names” in the moderate intensity condition. At this point in intervention (80 intervals after the onset of intervention), the cumulative frequency of off-task behavior was 22,
14, and 17 in the low, moderate, and high intensity condition, respectively. In the constant opportunities condition, the rate of off-task behavior was greatest in the high intensity condition. The first target Alice mastered was “how old are you?” in the high intensity condition. At this point in intervention (146 intervals after the onset of intervention), the cumulative frequency of off-task behavior was 5, 9 and 11 responses in the low, moderate, and high intensity condition, respectively.

Claire showed less differentiation in her rates of positive affect (Figure 6) between intensity conditions than Alice or John. Claire showed low rates of positive affect across all three intensity levels when the ISI was held constant, indicated by the shallow slopes. The first target Claire mastered was, “what is your brother’s name?” in the low intensity condition. At this point in intervention (62 intervals after the onset of intervention), rates of positive affect increased in the moderate intensity condition. In the constant duration condition, Claire displayed similar rates of positive affect in the three intensity conditions until 67 intervals into intervention. At this point, her rate of positive affect increased in all three conditions with the steepest slope occurring the low intensity condition, followed by the high and moderate intensity conditions. In the constant opportunities condition, Claire showed the greatest rates of positive affect in the moderate intensity condition until the 30th interval, when rates of positive affect in the low intensity condition increased.

The rate of Claire’s off-task behavior did not systematically vary with the different intensity conditions (Figure 7). During the ISI constant condition, initially, Claire’s, off-task responses occurred at higher rates during the low and moderate intensity conditions compared to the high intensity condition. At the 50th interval, rates of off-task responses increased in the high intensity condition. The first target Claire mastered was, “what is your brother’s name?” in the
low intensity condition. At this point in intervention (62 intervals after the onset of intervention), the cumulative frequency of off-task responses was 8 in all three conditions. When session duration was held constant, Claire displayed no off-task behavior until 49 intervals into intervention when rates increased in all three intensity conditions. The first target Claire mastered was “What city do you live in?” in the high intensity condition. At this point in intervention (100 intervals into intervention) the greatest cumulative frequency of off-task behavior occurred in the high intensity condition (17 cumulative responses), followed by the low (11 cumulative responses) and moderate conditions (5 cumulative responses). When the number of opportunities was held constant, Claire showed no off-task responses until the 26th interval; at the 50th interval, the rate off-task behavior increased in the moderate intensity condition.
Discussion

In order to examine how varying doses of a behavior-analytic intervention affect acquisition and task persistence, we manipulated three parameters of dose: the number of opportunities, inter-stimulus interval, and session duration. The results from the three participants showed that high intensity intervention conditions were more efficient than low or moderate doses of intervention, requiring fewer minutes to master targets. Children also showed systematic differences as a function of intensity in two measures of task-persistence, although the conditions that produced the highest rates of off-task and positive affect response were variable.

Previous research on the effects of the dose of intervention (Dunlap et al., 1983; Koegel et al., 1980; Neil & Jones, 2014) suggests that the spacing of opportunities, or ISI, is an important moderator of acquisition. Consistent with the results of these studies, we found shorter ISI’s lead to faster acquisition than longer ISIs. Further, this study extended previous research by demonstrating that shorter ISI’s lead to faster acquisition, regardless of the number of opportunities or the session duration. By comparing the speed of skill acquisition across three manipulations of dose, we were able to isolate the effects of the spacing of opportunities (ISI), from the number of opportunities and the session duration. When the ISI was held constant, but the number of opportunities and session duration varied, children acquired targets at similar rates.

Manipulating dose produced individual differences during the different intensity levels in the two measures of task persistence: positive affect and off-task behavior. For John and Alice, moderate intensity levels produced greater expression of positive affect. Varying intensity levels did not produce systematic differences in Claire’s expression of positive affect. John showed little off-task behavior. Alice and Claire also showed less consistency in the effects of the
differing intensity levels of off-task behavior. Previous research also finds variable results in the effects of dose on challenging behavior and task engagement. Some find greater rates of challenging behavior with higher doses (Roxborough & Carbone, 2012) and others find the opposite (Dunlap et al., 1983). The findings from this study, and from others, suggests that dose alone may not impact task-persistence.

The current study extends the literature on the effects of dose of intervention through the use of multiple control conditions. We designed a series of conditions, which controlled for the effects that manipulating one parameter of dose has on other parameters of dose. There may, however, be other uncontrolled aspects of intensity that affected the outcomes. The rate of reinforcement was not maintained across intensity levels. As children had similar levels of correct responding across all conditions, high intensity conditions produced greater rates of reinforcement than low intensity due to the faster pacing of opportunities. On the other hand, if escape from tasks served as a reinforcer, then low intensity conditions had greater magnitudes of reinforcement. Both magnitude and rate of reinforcement are directly related to the momentum (or resistance to change) of operant responding (e.g., Nevin, 1992). Thus, rate of reinforcement may have affected how quickly individuals mastered targets, and may contribute to how long individuals maintain these targets. For example, Dube and McIlvane (2002) found responding by individuals with developmental disabilities trained under a schedule with a higher rate of reinforcement (continuous) was more resistant to change than responding trained under a lower rate (intermittent) of reinforcement. In a follow-up study, researchers may want to consider paradigms which compare rates of opportunities while holding the rate of reinforcement constant (e.g., Porritt, Van Wagner, & Poling, 2009).
In addition to controlling aspects of intensity, we also attempted to control for the difficulty of targets across intensity conditions. It is still a possibility that some targets were easier than others. We did not control aspects of the $S^D$ such as the length of the questions or similarity of the questions, nor did we control the familiarity of the target questions. Thus, differences in acquisition rates may be a result of differences in response difficulty or characteristics of the $S^D$, rather than intensity parameters. These uncontrolled aspects may have influenced the task-persistence measures; children may show more positive affect when presented with more familiar $S^D$s and fewer off task responses when asked to produce less difficult responses. One solution to this is to replicate these procedures using between-group randomized experiments. Between-groups experiments allow the experimenter to use the same acquisition targets at both high and low intensities with different children, ensuring the difficulty is the same for both intensity levels. Between-group designs, however, are more susceptible to effects of pre-intervention participant differences requiring experimenters to ensure that participants are relatively similar prior to intervention.

One of our outcome measures was the efficiency of skill acquisition measured as total intervention duration in minutes to mastery. Faster acquisition of targets under high intensity conditions led to shorter total durations of intervention than during low intensity conditions. These differences were on the order of minutes; overall, intervention occurred over only a few weeks. Another approach is to hold the duration of intervention constant while measuring a different dependent variable, such as the number of skills acquired. For example, providing 3 months of high dose or low dose intervention and comparing the total number of targets acquired across the two interventions. Fey, Yoder, Warren, and Bredin-Oja (2013) used this approach to assess the effects of manipulating dose frequency of milieu-communication therapy on
communication outcomes for children with developmental disabilities. They randomly assigned children with developmental disabilities to 9 months of milieu-communication therapy provided one time per week or 5 times per week. They found intervention delivered at high-dose frequencies led to greater vocabulary production. Measuring the time to master a single skill at a given intervention intensity or the number of skills mastered over a period of time in a given intensity allows researchers to determine the rate at which children acquire skills, or the efficiency of intervention.

Unlike efficiency of skill acquisition, systematic differences in task-persistence only occurred for some children. This study is the first to use a behavioral measure of task-persistence as an outcome of intervention and it is possible that this measure did not accurately capture the children’s level of task-persistence. The measure was created based on two indicators of task-persistence (off-task behavior and expression of affect) from a commonly used assessment in the developmental literature (Morgan, Busch-Rossnagel, Maslin-Cole, Harmon, 1992). These two indicators of task persistence are not without limitations; while interobserver agreement for off-task behavior was high, agreement for affect was lower. The lower ranges of agreement for affect are consistent with other studies assessing affect in individuals with developmental disabilities (e.g., Kennedy & Haring, 1993) and may be a result some of practical issues in assessing affect (e.g., camera angle) in conjunction with the subjectivity of judging facial expression. Affect and off-task behavior are also not the only indicators of task-persistence measured in the literature. Other studies (e.g., Kasari & Freeman, 2001) measured latency to begin tasks and time to complete tasks in addition to off-task behavior and affect when assessing task persistence in children with Down syndrome. While affect and off-task behavior may reflect some aspect of
task persistence, topography of task-persistence may vary across individuals or there may be other, uncaptured, topographies of task-persistence that were not measured in this study.

In order to assess the relative effects of the differing intensity levels on task-persistence, we focused our analysis on the period of time when all three levels of intensity were in place. This period of time allows for the demonstration of experimental control in an alternating treatment design. It is worth noting, however, that, when targets were mastered in one level of intensity (and, therefore, intervention terminated at that level of intensity) some changes in the rate of positive affect or off-task behavior occurred in the other intensity levels. For example, during the constant opportunities manipulation, John's off task behavior increased in the low intensity condition after intervention terminated for the other targets. This suggests that there may be contrast effects that arise from presenting multiple intensity levels to the same individual concurrently. Again, a between groups design would allow for demonstration of the effects of these intensity levels presented alone.

Designing intervention intensity studies and identifying relevant outcome measure is only one of the challenges of intervention intensity research. Another complication is child characteristics and how those characteristics interact with intensity. None of the pre-intervention characteristics we assessed appeared to affect acquisition outcomes in this study. The children in our study were relatively narrow in age range and functioning level, and this may have contributed to the homogeneity of the results. It is possible, however, that there may be additional participant characteristics, which we have not yet considered, that interact with intervention intensity. For example, Fey et al. (2013) found both etiology and object interest moderated the effects of dose frequency. In a randomized controlled trial, children with high
object interest, and who did not have Down syndrome, responded more positively to 5 hours/week of than 1 hour/week of milieu-communication therapy.

Considering the number of individual characteristics that may moderate the effects of intervention intensity, one solution may be to use present varying intensities of intervention using the alternating treatment designs within these studies as a brief individual assessment for designing appropriate instructional conditions. Examples of the success of this approach can be seen in the use of functional analysis of problem behavior upon which to base an intervention (Hanley et al. 2003). This approach has recently been applied to intervention intensity; Hagan-Burke, Gilmour, Gerow and Crowder (2015) used alternating treatment design to determine the intensity of instruction that occasioned problem behavior. They found reducing the pace of instruction resulted in reduced problem behavior and increased academic responding. Using this approach as a model, an interventionist may include an assessment that presents several intensities of an instructional approach while measuring acquisition rates and other relevant behavior (e.g., on-task behavior). The interventionist could use this information to design an intervention with an optimal intensity for that child.

In addition to participant characteristics, skill area may also moderate the effects of intervention intensity. In this study, intervention targeted expressive language (a relative weakness in young children with Down syndrome; Fidler, 2005). Weaknesses identified as part of the Down syndrome behavioral phenotype such as expressive language may be in need of more intensive intervention to result in acquisition of target skills than strengths. When intervention focuses on relative strengths, children may show a different response to intervention intensity. Future studies should examine how different skill areas (e.g., motor, communication, visual performance) interact with intervention intensity.
The results of this study can guide practitioners in developing effective intervention practices for children with Down syndrome. First, skill acquisition occurred at the fastest rate when opportunities were presented close together. This does not necessarily mean that fast-paced sessions will always produce the fastest acquisition; rather, for these children and this skill area, faster paced sessions were superior. Continued research is needed to determine how to optimize acquisition for skill acquisition in different skill areas, for children with a variety of characteristics.

Second, practitioners need to balance the need for children to learn quickly with other behavior during intervention sessions. For all three children, the highest intensity levels did not produce the greatest on-task behavior and positive affect. A child’s reaction to a given intensity level has the potential to influence many other outcomes. Parents and interventionists may respond more positively to interventions in which children display fewer problem behaviors and greater positive affect. Positive affect may evoke positive responses from practitioners, such as increased and more positive social interaction and continued presentation of opportunities. On the other hand, off-task behavior and negative affect may result in a practitioner reducing interaction with the child and presenting fewer learning opportunities. Compounded over time, these relatively small differences in child behavior may become significant differences in a child’s response to intervention conditions.

Conclusion

In figuring out how to maximize outcomes for children with Down syndrome, it is not just about the most effective approach, but how much of that effective approach. An inaccurate amount of intervention, whether too high or low, is as problematic as an ineffective approach to intervention. Using three manipulations of dose, this research suggests that pacing of
opportunities is one important moderator of acquisition and task-persistence outcomes in a behavior-analytic approach to intervention for communication among young children with Down syndrome. High doses of intervention resulted in more efficient acquisition of communication targets. It is likely, however, that different interventions, different individual characteristics, and different skill areas will require different variations in intensity levels. Developing effective treatments and identifying optimal intensities for individuals with Down syndrome will require carefully designed studies to address the complexity of intervention intensity.
Table 1

*Participant Characteristics.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>IQ</th>
<th>Mullen Expressive</th>
<th>Adaptive Behavior Composite</th>
<th>Vineland Communication</th>
<th>CDI Words Understood</th>
<th>CDI Words Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>2:9</td>
<td>67</td>
<td>Below Average (7%ile)</td>
<td>75 (Mod Low)</td>
<td>86 (Adequate)</td>
<td>321</td>
<td>115</td>
</tr>
<tr>
<td>Claire</td>
<td>5:8</td>
<td>49</td>
<td>Very Low (&lt;1%ile)</td>
<td>67 (Low)</td>
<td>72 (Mod. Low)</td>
<td>331</td>
<td>268</td>
</tr>
<tr>
<td>John</td>
<td>5:7</td>
<td>49</td>
<td>Very Low (&lt;1%ile)</td>
<td>66 (Low)</td>
<td>78 (Mod. Low)</td>
<td>242</td>
<td>224</td>
</tr>
</tbody>
</table>

*Note: Mullen = Mullen Scales of Early Learning; Vineland-II = Vineland Adaptive Behavior Scales, Second Edition; CDI = MacArthur-Bates Communicative Development Inventories*
Table 2

*Levels of dose manipulations.*

<table>
<thead>
<tr>
<th>Condition</th>
<th>ISI (s)</th>
<th>Duration (s)</th>
<th>Opportunities</th>
<th>Integrity for ISI (s)</th>
<th>Integrity for duration</th>
<th>Integrity for number of opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interstimulus Interval Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>30</td>
<td>60 (1 min)</td>
<td>2</td>
<td>38</td>
<td>77</td>
<td>2</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>30</td>
<td>150 (2.5 min)</td>
<td>5</td>
<td>34</td>
<td>191</td>
<td>5</td>
</tr>
<tr>
<td>High Intensity</td>
<td>30</td>
<td>300 (5 min)</td>
<td>10</td>
<td>35</td>
<td>320</td>
<td>10</td>
</tr>
<tr>
<td><strong>Session Duration Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>300</td>
<td>600 (10 min)</td>
<td>2</td>
<td>258</td>
<td>527</td>
<td>2</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>120</td>
<td>600 (10 min)</td>
<td>5</td>
<td>104</td>
<td>528</td>
<td>5</td>
</tr>
<tr>
<td>High Intensity</td>
<td>60</td>
<td>600 (10 min)</td>
<td>10</td>
<td>50</td>
<td>529</td>
<td>10</td>
</tr>
<tr>
<td><strong>Number of Opportunities Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>150</td>
<td>750 (12.5 min)</td>
<td>5</td>
<td>120</td>
<td>715</td>
<td>5</td>
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<tr>
<td>Moderate Intensity</td>
<td>60</td>
<td>300 (5 min)</td>
<td>5</td>
<td>58</td>
<td>314</td>
<td>5</td>
</tr>
<tr>
<td>High Intensity</td>
<td>30</td>
<td>150 (2.5 min)</td>
<td>5</td>
<td>31</td>
<td>174</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 3

*Targets assigned to each dose parameter.*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Alice</th>
<th>Claire</th>
<th>John</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interstimulus Interval Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>What do you like to eat?</td>
<td>What’s your brother’s name?</td>
<td>The opposite of tall is “short”</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>Where do you live?</td>
<td>What’s your last name?</td>
<td>The opposite of loud is “quiet”</td>
</tr>
<tr>
<td>High Intensity</td>
<td>Where do you go to school?</td>
<td>How old are you?</td>
<td>The opposite of clean is “dirty”</td>
</tr>
<tr>
<td><strong>Session Duration Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>What’s your last name?</td>
<td>What street do you live on?</td>
<td>The opposite of soft is “hard”</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>What’s your brother’s name?</td>
<td>What do you like to drink?</td>
<td>The opposite of strong is “weak”</td>
</tr>
<tr>
<td>High Intensity</td>
<td>What do you like to drink?</td>
<td>What city do you live in?</td>
<td>The opposite of young is “old”</td>
</tr>
<tr>
<td><strong>Number of Opportunities Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>What do you play with?</td>
<td>What do you like to eat?</td>
<td>The opposite of thick is “thin”</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>What’s your name?</td>
<td>What do you play with?</td>
<td>The opposite of light is “dark”</td>
</tr>
<tr>
<td>High Intensity</td>
<td>How old are you?</td>
<td>How many brothers do you have?</td>
<td>The opposite of right is “left”</td>
</tr>
</tbody>
</table>

Note: Answers for Alice and Claire are not provided to protect the participant’s identities.
Table 4

*Mean opportunities to mastery, minutes to mastery, and % correct on generalization probes for each dose manipulation.*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean Opportunities to mastery</th>
<th>Mean Min. to mastery</th>
<th>Mean % Correct on Generalization Probes at Post-Mastery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interstimulus Interval Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>14.33</td>
<td>7.17</td>
<td>78 % [67-100]</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>19.67</td>
<td>9.83</td>
<td>83 % [67-100]</td>
</tr>
<tr>
<td>High Intensity</td>
<td>18</td>
<td>9</td>
<td>94 % [83 -100]</td>
</tr>
<tr>
<td><strong>Session Duration Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>17</td>
<td>85</td>
<td>94 % [83 - 100]</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>12.33</td>
<td>24.67</td>
<td>100 % [100 - 100]</td>
</tr>
<tr>
<td>High Intensity</td>
<td>23.67</td>
<td>17.5</td>
<td>100 % [100 - 100]</td>
</tr>
<tr>
<td><strong>Number of Opportunities Held Constant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Intensity</td>
<td>20.67</td>
<td>51.67</td>
<td>100 % [100 - 100]</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>15.67</td>
<td>15.67</td>
<td>94 % [83 - 100]</td>
</tr>
<tr>
<td>High Intensity</td>
<td>21.57</td>
<td>10.83</td>
<td>100 % [100 - 100]</td>
</tr>
</tbody>
</table>
Figure 1. Opportunities to mastery, minutes to mastery, and % correct responding for each intensity manipulation for all participants. The x-axes show the number of opportunities, ISI and session duration for the low, moderate, and high intensity conditions of each manipulation.
Figure 2. Cumulative intervals with positive affect during low, moderate, and high intensity level conditions for John.
Figure 3. Cumulative intervals with off-task behavior during low, moderate, and high intensity level conditions for John.
Figure 4. Cumulative intervals with positive affect during low, moderate, and high intensity level conditions for Alice.
Figure 5. Cumulative intervals with off-task behavior during low, moderate, and high intensity level conditions for Alice.
Figure 6. Cumulative intervals with positive affect during low, moderate, and high intensity level conditions for Claire.
Figure 7. Cumulative intervals with off-task behavior during low, moderate, and high intensity level conditions for Claire.
Bibliography


*Down Syndrome Research and Practice Syndrome Research and Practice*, 7(2), 47–51. 
http://doi.org/10.3104/reports.113


http://doi.org/10.1352/1944-7558-119.1.17