JoDD

Journal on Developmental Disabilities
Volume 25 Number 1, 2020
On-Line First

The Effect of Instructional Pacing on Skill Acquisition and Maintenance for Children with Developmental Disabilities

Author Information

Nicole Neil[1]
Rebecca Hansford [2]
Kaitlyn Young,[2]
Larissa Zwick [1]

[1]Faculty of Education, Western university, London ON
[2] Department of Applied Disability Studies, Brock University, St. Catharines, ON

Correspondence:

nneil@uwo.ca

Keywords

Down syndrome,
autism spectrum disorder,
intervention intensity,
instructional pacing,
communication

Abstract

Discrete trial training is an instructional method based on the principles of applied behaviour analysis where skills are taught in discrete units. This instructional method has empirical support for increasing skills among children with developmental disabilities. Instructional pacing has been identified as a key variable in discrete trial training that may enhance skill acquisition. Instructional pacing is the rate at which each individual presentation of the instructional target occurs. Research examining the effects of varying the pace of instruction has produced inconsistent findings. This study sought to examine the effects of five paces of instruction on skill acquisition for young learners. Pace was manipulated by varying the interstimulus interval. Two children with a diagnosis of autism spectrum disorder and one with Down syndrome participated in the study. Instructional targets, the specific behavioural skills to be taught to the participants, included: tact: (expressive labelling—i.e., responding to a particular object or event or property of an object or event), listener responding (responding to an instruction), and intraverbal skills (responding to social questions). In contrast to earlier research, participants achieved mastery by demonstrating a previously determined level of skill without prompting in the fewest number of trials in the slowest pace condition. The pace of instruction associated with the fewest minutes to mastery, or most efficient pace, varied across participants. Skill maintenance also varied across participants. Results suggest that the optimal pace of instruction may vary across individuals. Implications for determining the optimal pace of instruction in discrete-trial training with young learners are discussed.

Introduction

Discrete-trial training (DTT) is an instructional method based on the principles of applied behaviour analysis (ABA) where skills are taught in small units of behaviour during highly structured, discrete learning trials (Kodak & Grow, 2011). Sessions include the presentation of a discriminative stimulus (S^D) (Cariveau, Kodak, & Campbell, 2016). This may include the presentation of the same S^D throughout the session (massed-trial instruction), interspersing mastered targets with the unmastered target (interspersed-trial instruction), or teaching two or more unmastered targets simultaneously in the session (varied-trial instruction; Cariveau et al., 2016). Prompts may also be delivered to specify correct responding (Cariveau et al., 2016). Following correct responses, highly preferred items and social praise are delivered. DTT has empirical support for increasing skills among children with developmental disabilities, including autism spectrum disorder (ASD) and Down syndrome (DS) (Bauer, Jones, & Feeley, 2013; Bauer & Jones 2014; Feeley & Jones 2006, 2008a, b, c; Feeley, Jones, Blackburn, & Bauer, 2011; Jones, Feeley, & Blackburn, 2010; Jones, Neil, & Feeley, 2013; Smith, 2001).

Researchers have begun to investigate how altering components of DTT, including the pace of instruction, affects outcomes. In a meta-analysis, Tincani and De Mers (2016) identified instructional pacing as a key variable to consider when examining programs that improve skills or decrease challenging behaviour. Increased pace of instruction, the rate at which each individual presentation of the instructional target occurs, may influence acquisition by reducing problem behaviour or stereotypy, increasing rates of reinforcement, and providing increased opportunities for responding (Roxburgh & Carbone, 2012). However, the effect of the pace of instruction on responding differs across studies (Carnine, 1976; Koegel, Dunlap, & Dyer, 1980, Roxburgh & Carbone, 2012; Skinner, Smith, & McLean, 1994).

Some studies have found positive effects of increasing the pace of instruction. Carnine (1976) examined the impact of the pace of instruction on off-task behaviour, correct responding, and participation during Level 1 Distar Reading Program tasks (Engelmann & Bruner, 1974) for low-performing first-grader children ($N = 2$). They compared a slow rate of presentation to a fast rate of presentation: a 5 s delay and a 0 s delay between instructions, respectively. The fast pace of instruction led to improved levels of correct responding and decreases in off-task behaviour, potentially due to the child attending to the instructor continuously.

Increased paces of instruction have also resulted in improved performance for individuals with developmental disabilities. Koegel and colleagues (1980) and Cariveau et al. (2016) explored the impact of the pace of instruction on skill acquisition of listener responses, verbal imitation, tacts, and intraverbals. Time between instructions (intertrial intervals; ITI) varied from 2 s (short condition) to 26 s (long condition). In both studies, skills were acquired within a smaller number of trials in the short ITI conditions. Further, Cariveau et al. (2016) found that the pace of instruction did not produce differential effects on skill maintenance.

Other studies have found no effects of varying the pace of instruction. Skinner and colleagues (1994) examined the impact of varying paces of instruction on sight-word acquisition in children with behavioural disorders. Using an alternating treatment design, they compared sight-word acquisition across two ITI conditions: 0 s and 5 s. In contrast to Carnine (1976) and Koegel et al. (1980), both interventions were equally effective in increasing and maintaining sight-word accuracy. This lack of functional relationship may have resulted from differences across individual attentional skills, competing stimuli (i.e., initially low levels of self- stimulatory behaviour), or reinforcer strength. Skinner and colleagues (1994) also emphasized consideration of the strategies between instruction, such as increasing the learner's opportunities to engage in appropriate behaviours.

The variability in acquisition and maintenance results demonstrate that further examination of the influence of varying pace of instruction is required. Previous research is limited in that it has compared a fast to a slow pace of instruction (Carnine, 1976; Koegel et al., 1980; Skinner et al., 1994). Only two studies examined three rates of presentation: low, medium, and high paces of instruction (e.g., Cariveau et al., 2016; Roxburgh & Carbone, 2012). Furthermore, maintenance has not been consistently assessed across pacing studies (Carnine, 1976; Koegel et al., 1980; Rexburg & Carbone, 2012). The current study, therefore, will replicate and extend previous research by examining the effects of five paces of instruction on acquisition during DTT. We will also assess maintenance of skills at 1 week, 2 weeks, 1 month and 2 months to understand the long-term effects of the pace of instruction.

Method

Participants

The Western University Institutional Review Board approved this study and parents provided informed and voluntary consent for participation. Two boys and one girl (pseudonyms: Tommy, Max, and Julia) with an outside diagnosis of a developmental disability (DD; based on parent report) participated in the study. Participants were recruited via the listserv of a local developmental disabilities advocacy organization. None of the participants had previously received ABA intervention services or discrete-trial instruction of verbal behaviour. The Preschool Language Scale 5th edition (PLS-5; Zimmerman, Steiner, & Pond, 2011), and Vineland Adaptive Behavior Scales-Third Edition (Vineland-3; Sparrow, Cicchetti, & Saulnier, 2016) were conducted prior to baseline. The PLS-5 is designed for use with children to assess language development and consists of two standardized scales: Auditory Comprehension (AC), to evaluate the scope of a child's comprehension of language, and Expressive Communication (EC), to determine how well a child communicates with others. The Vineland-3 evaluates adaptive functioning in four domains: Communication, Daily Living Skills, Socialization and Motor Skills. Parents/caregivers completed the "Parent/Caregiver Rating Form" by rating each item with respect to how often the child demonstrated the behaviour on a scale of 0 (*no, never*), 1 (*sometimes, or partially*), 2 (*yes, usually*), or DK (*don't know*), although some items may be rated N (*no opportunity*).

Tommy, age 4 years 4 months, has DS. Tommy spontaneously vocally manded (requested), and tacted (labelled) items using one word and, occasionally, two-word phrases. Tommy was able to complete simple intraverbal phrases such as filling in lyrics of songs. For instance, if the therapist sang "A, B.." and paused, Tommy would respond "C". Tommy also spontaneously used non-specific intraverbal phrases such as "I got it". Echolalia (repetition of words and phrases) was heard frequently. On the PLS-5, Tommy's score was 60 for expressive language, 63 for auditory comprehension, and 59 total, with an age equivalence of 2 years 4 months. On the Vineland-3, Tommy's communication score was 71(3rd percentile), socialization score was 70 (2nd percentile) and composite score was 70 (2nd percentile).

Max, age 2 years 7 months, had a diagnosis of ASD. Max primarily communicated with gestures and words. He spontaneously vocally manded (requested) for a moderate number of preferred items (approximately 40) and had been observed to tact (label) items, numbers, and letters.

Echolalia was frequently observed. On the PLS-5, Max's score was 77 for expressive language, 57 for auditory comprehension, and 65 total, with an age equivalence of 1 year 6 months. On the Vineland-3, Max's communication score was 54 (<1st percentile), socialization score was 69 (2nd percentile) and composite score was 55 (<1st percentile).

Julia, age 5 years, had a diagnosis of ASD. Julia primarily communicated with gestures and vocalizations, spontaneously manded (requested) for a small number of preferred items and actions using vocalizations (approximately 20) including requesting others to "stop", come "here", and "sit". She labelled a variety of preferred objects without prompts. On the PLS-5, Julia's score was 55 for expressive language, 50 for auditory comprehension, and 50 total, with an age equivalence of 1 year 11 months. On the Vineland-3, Julia's communication score was 63 (1 percentile), socialization score was 79 (8th percentile) and composite score was 68 (2nd percentile).

Setting and Interventionists

Intervention took place in participants' homes. Participants sat in a chair at a child-sized table. The interventionist sat in a chair or on the floor opposite or at 90-degrees. Task materials were laid out on the floor or table in front of the interventionist. A video camera placed on a tripod recorded each session. The interventionists were graduate students in Master of Arts degree in Applied Disability Studies with a Specialization in ABA. Interventionists participated in a 3-hour training prior to intervention where each interventionist achieved treatment fidelity, the measurement of the degree to which the intervention is implemented as intended, of 90% or higher during a single role-play.

Materials

All random allocation of intervention target pace and within-session order were done using an online random number generator (Urbaniak & Plous, 2013). A list of preferred items to deliver as reinforcers was determined using the Reinforcement Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996).

Design

We used an adapted alternating treatments design to examine the effect of five paces of instruction on skill acquisition. Pace was manipulated by varying the interstimulus interval (ISI; the time between presentations of the S^D). The five paces of instruction included the following ISI durations: 150 s, 120 s, 60 s, 45 s, and 30 s. Table 1 details the ISI, duration, and number of trials for each of the five conditions. Intervention targets were randomly assigned to a pace (Table 2).

Table 1
Programmed Pace Manipulations and Procedural Fidelity During Intervention and Maintenance

			Mean Fidelity			
			Intervention		Maintenance	
ISI (s)	Duration (s)	Trials	ISI (s)	Steps (%)	ISI (s)	Steps (%)
150	750 (12.5 min)	5	150.0 (149.0-150.8)	96.2 (93.6-98.4)	153.2 (150.9-155.3)	96.8 (95.0-98.2)
120	600 (10 min)	5	119.8 (115.0-131.3)	93.8 (89.1-98.)	121.0 (120.4-121.5)	95.5 (93.7-98.3)
60	300 (5 min)	5	66.4 (60.3-75.3)	91.6 (86.5-96.1)	71.0 (61.0-90.3)	91.2 (82.0-100.0)
40	200 (3.3 min)	5	50.9 (47.3-57.1)	91.6 (81.9-98.4)	42.5 (40.1-46.5)	95.4 (92.2-97.3)
30	150 (2.5 min)	5	33.0 (30.6-35.3)	93.1 (91.3-94.5)	35.9 (30.4-46.9)	93.6 (87.3-96.8)

Note. ISI: interstimulus interval, the time between presentations of the discriminative stimulus (S^D) in seconds. Duration: total length of time required for all presentations of each instructional target per session. Mean Fidelity columns show the mean ISI delivered to participants and mean percentage of intervention steps described in the checklist implemented as planned, with the range, or maximum and minimum proportion of steps completed correctly presented in parentheses.

Table 2
Targets Assigned to Each Pace of Instruction

ISI	Tommy	Max	Julia
150	What number? "4"	Knock	Mom’s name
120	What number? "6"	Blow kiss	Age
60	What number? "5"	Tap table	Dad’s name
40	What number? "2"	Clap	City
30	What number? "3"	Wave	Favourite drink

Note. ISI: interstimulus interval, the time between presentations of the discriminative stimulus (S^D) in seconds. For example, for Tommy, the tact target “4” was assigned to the ISI interval, 150. For each trial until mastery, the therapist presented the instruction (S^D), “What number?” and held up a visual of the number 4, prompted (if necessary), assessed the response as correct/incorrect and provided a consequence. The next trial for target “4” was presented in 150 seconds after the presentation of the previous instruction (S^D).

Response Measurement, Interobserver Agreement, and Procedural Fidelity

Response measurement

The targets of intervention varied across participants and included tacts (identifying numbers), listener responses (performing one-step instructions), and intraverbals (answering social questions). The interventionist recorded child performance of responses during sessions on data sheets. On each opportunity, the interventionist delivered the relevant S^D. The interventionist marked an independent correct response when the child produced the target response independently (i.e., without prompting) within 3 s of the S^D. She recorded a prompted response if the child produced the target response after an S^D that also included a prompt (see procedures section for a description of the prompts). An incorrect response was recorded when the child did not produce the target response or produced a response other than the target response (e.g., repeating all or part of the S^D).

We measured three summative acquisition outcomes: trials to mastery (the number of trials required to perform the target correctly without prompts for four consecutive trials), time to mastery, and percentage of correct responding. Participant responding was considered mastered when he or she emitted independent correct responses during three consecutive trials within a session followed by a correct response on the first trial presented the following session (a total of four independent correct trials). Trials to mastery were the sum of the trials presented once intervention began (after baseline) through the four trials on which the child met mastery criteria. We calculated time to mastery by multiplying the ISI for the condition by the total number of trials to mastery. Percentage of correct responding was the number of the correct responses throughout intervention (prompted and independent) divided by the sum of correct (prompted and independent) and incorrect responses, multiplied by 100%.

Interobserver agreement

Interventionists and observers attended a 3-h training session where attendees were shown sample intervention videos prior to scoring performance during the study. Throughout the study, independent observers calculated interobserver agreement (IOA) using reliability data scored from video-recordings of intervention and maintenance sessions. Trial-by-trial agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100 (Cooper, Heron, & Heward, 2007). IOA was determined for 22.2%, 41.2%, and 34.7% of Tommy's, Max's, and Julia's sessions, respectively. Mean agreement was 86.8% (40-100%) for Tommy, 88.1% (33-100%) for Max, and 88.6% (40-100%) for Julia. IOA was determined for 50% of maintenance sessions for each participant. Agreement for Tommy was 85.5% (20-100), Max was 92.5% (50-100) and Julia was 82.0% (20-100). Low agreement occurred during the initial sessions and coding differences were resolved in a meeting where consensus was reached between interventionists and observers.

The same observers assessed procedural fidelity from video recordings using a checklist outlining all components of intervention. The observers recorded the duration of the ISI to ensure adherence to the pace of intervention. Observers assessed 30.8% and 50.0% of sessions in intervention and maintenance, respectively, for procedural fidelity. Table 1 shows the scheduled ISI, the mean observed ISI and fidelity for the intervention steps for each pace of instruction across all children.

Procedures

Pre-assessment and target selection

In a single 1.5 h session, the interventionist obtained parental consent and conducted the Vineland-III (Sparrow et al., 2016), PLS-5, and the RAISD (Fisher et al. 1996).

For each child, five targets were identified. Targets were tailored to the child according to current areas of need based upon pre-assessments as well as input from the parents. Targets were selected to be age appropriate but not yet within the child's current repertoire. Targets are listed in Table 2. Targets were then randomly assigned to an ISI condition.

Baseline

Baseline sessions consisted of six trials spaced 5 min apart during a 30 min session. This represented a pace that did not mirror any of the intervention paces. Each participant completed two baseline sessions. During each baseline opportunity, the interventionist presented the S^D and provided the child with a 3-s interval to produce the response. Following a correct response, no response, or other response, the interventionist did not deliver any feedback to the child. Verbal praise for sitting, attending, or looking was provided independent of correct or incorrect responses at 30 s intervals during the baseline sessions. Between baseline opportunities, the participants were provided access to a variety of moderately-preferred items and activities, identified by parent and child report, which were varied across sessions.

Intervention

Initially, intervention sessions were 1 h, occurring between 1 and 3 times per week. They consisted of 25 trials, five trials of each of the five targets presented at their assigned ISIs (the time between presentations of the S^D) of either 30 s, 40 s, 60 s, 120 s, or 150 s. For instance, in the 30 s condition, the teacher would present the S^D, "Touch your eyes" every 30 s for five trials. One intervention session consisted of the presentation of all five targets and ISIs. Within the session, the order of the presentation of the conditions was determined using a random number generator.

When participants reached mastery for an intervention target, trials of the mastered targets were no longer conducted during the intervention session. Therefore, the total number of trials in the intervention session was reduced by five. When participants reached mastery for the majority of intervention targets, five-trial blocks of remaining targets were presented multiple times within a at the assigned pace of instruction (i.e., five trials of targets not yet mastered were presented more than once within the regular one hour scheduled intervention time period) to provide a consistent duration of DTT across each week.

At the beginning of each session, the interventionist assessed a current hierarchy of preferred items using a multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996). Items presented were selected from available items in the setting using information from the RAISD, parent report, child report, and interventionist observation.

Intervention was a DTT format. The interventionist used a most-to-least prompt fading hierarchy and 3-s prompt delay. Prompts were faded using a within-session prompt fading hierarchy (Neil & Jones, 2015). To prompt correct responses for participants Tommy and Julia, the interventionist used a full verbal model presented simultaneously with a visual cue (a cue card with the target response written in full), which was later faded to a visual cue as per the prompt fading hierarchy. To prompt correct responses for Max, the interventionist used a full physical prompt, which was later faded to a partial physical prompt as per the prompt fading hierarchy. Following fading of the partial prompt for all participants, the interventionist waited 3 s for the child to respond independently after presenting the S^D. Mastery was achieved for each target when the child emitted independent correct responses during three consecutive trials within a session and an independent correct response on the first trial presented in 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 highly-preferred tangible items identified through the MSWO. Incorrect responses were followed by neutral feedback statements (e.g., "nice try") and the delivery of less-preferred items identified through the MSWO. Between intervention opportunities, the participants engaged with the tangible item delivered in the previous trial and were provided access to a variety of moderate- and low-preferred items and activities, identified through the MSWO. Between the presentation of each pace of instruction, 5-minute breaks were provided where the interventionist did not place any demands and engaged participants in an activity (e.g., playing with toy cars, colouring) that had been identified as not highly preferred.

Maintenance

Maintenance was conducted following the same procedures as intervention for all conditions, however, prompts and reinforcement were not provided. Maintenance was completed 1 week, 2 weeks, 1 month and 2 months post mastery.

Results

Table 3 outlines the trials to mastery, the minutes to mastery, and the percentage of correct responding during the intervention and maintenance phases for each condition (i.e., one trial every 2.5 min, 2 min, 1 min, 40 s, and 30 s). Figure 1 depicts cumulative independent trials during the baseline and intervention phases for each participant.

Intervention resulted in gradual increases in performance which varied across conditions for Tommy. Tommy reached mastery (i.e., four independent trials consecutively) within the fewest number of trials in the slowest pace or 2.5 min condition (target skill of four), with 21 trials and 52.5 min to mastery (see Figure 1). This skill was maintained over time with a mean correct responding of 95%. Tommy reached mastery in the fewest minutes in the 40 s condition, with 29 trials and 19.3 min to mastery for the target skill of two. This skill was maintained over time with a mean correct responding of 85%. Mastery was achieved in the 2 min condition (target of six) in 41 trials with 82 min to mastery. The target skill was maintained over time (M = 85%). Tommy reached mastery in the greatest number of trials with the greatest number of minutes to mastery in the 60 s condition (target of number five). Mastery criterion was reached in 107 trials and 107 min for this condition. This skill was partially maintained over time with a mean correct responding of 65%. In the fastest pace condition (one trial every 30 s), mastery was reached for the target of three in 88 trials and 44 min. The target skill was maintained over time (M = 85%).

For Max, the intervention resulted in immediate increases in performance in the slowest pace of instruction (one trial every 2.5 min and 2 min; see Figure 1). Max reached mastery within 11 trials for both the 2.5 min and 2 min condition (targets were knock and blow kiss, respectively).

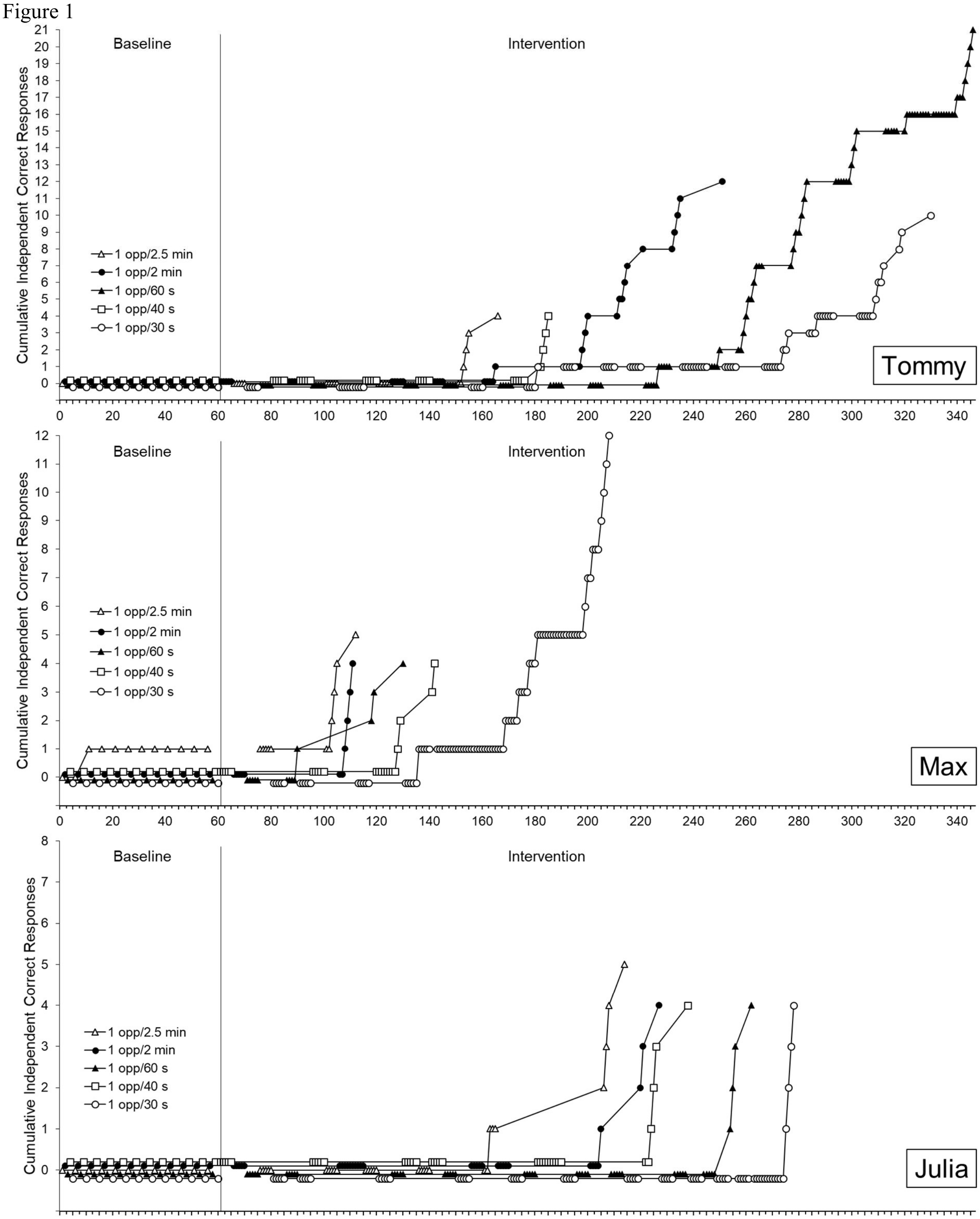
Table 3

Mean Trials to Mastery, Minutes to Mastery, % Correct During Intervention and % Correct During Maintenance for all Participants for Each Pace Manipulation

	Intervention			Maintenance			
ISI (s)	Trials to Mastery	Min to Mastery	% Correct	1 Week (%)	2 Week (%)	1 Month (%)	2 Month (%)
Tommy							
150	21	52.5	71	100	100	80	100
120	41	82.0	68	100	80	60	100
60	107	107.0	60	0	100	80	80
40	29	19.3	69	100	100	40	100
30	88	44	57	80	60	100	100
Max							
150	11	27.5	100	80	100	100	100
120	11	22.0	91	100	80	100	80
60	13	13.0	92	100	100	100	100
40	22	14.7	59	60	100	60	60
30	91	45.5	52	40	20	20	20
Julia							
150	29	72.5	48	100	20	40	100
120	33	66.0	76	100	80	80	100
60	49	49.0	33	60	100	60	80
40	36	24.0	50	100	100	60	80
30	71	35.5	30	100	100	60	100

Note: For all participants, the slowest pace of instruction (150 s condition) produced the most efficient skill acquisition (fewest minutes and trials to master the skill). Maintenance varied across targets.

Figure 1



Cumulative independent correct responses for Tommy, Max and Julia for each pace manipulation (in s) during baseline and intervention. Mastery occurred after four consecutive independent correct responses. Children may have demonstrated independent correct. responding which did not meet mastery criteria resulting in a differing number of cumulative correct responses for each target. Targets in the slowest past of instruction (open triangles) were mastered first for all children demonstrated by the earliest acceleration in each plot.

Minutes to mastery were relatively longer in these conditions, 27.5 and 22 min for the 2.5 min and 2 min conditions respectively. Skills were maintained during these conditions, with a mean correct responding of 95% for the 2.5 min condition and 90% for the 2 min condition. Max also reached mastery criterion efficiently during the 60 s condition (target was tap table). Mastery criterion was achieved in 13 trials for this condition. This condition produced mastery within the shortest amount of time (13 min to mastery) and this target skill was maintained over time (*M* = 100%). The fast-paced conditions required the greatest number of trials to obtain mastery, with 22 and 91 trials for the 40 s and 30 s conditions, respectively. Maintenance of skills was lower in these conditions (*M* = 70% for 40 s condition; *M* = 25% for 30 s condition).

Julia exhibited gradual increases in correct responding (see Figure 1). She reached mastery criterion in the fewest number of trials during the 2.5 min condition (target was "what is your mom's name?"). In this condition, she reached mastery within 29 trials; however, the minutes to mastery was 72.5 min. Maintenance was varied, with a mean of 65%. Julia produced the lowest rate of responding during the 30 s condition (target was "what do you like to drink?") as she reached mastery criteria within 71 trials. Although correct responding was lowest during the interval in this condition (30%), the participant maintained this skill during maintenance (*M* = 90%).

Discussion

In this study, the effects of five paces of instruction on skill acquisition in children with Down syndrome (*N* = 1) or ASD (*N* = 2) were examined. Verbal skills were taught to the participants, including one-step instructions, social questions, and identifying numbers. The pace of instruction was varied (one trial per 30 s, 40 s, 60 s, 120 s, and 150 s) while all other factors were held constant. Across all participants, the slowest pace (i.e., 150 s) resulted in mastery of skills within the fewest number of trials. However, the pace of instruction associated with the fewest minutes to mastery varied depending on the participant. Although high levels of maintenance were frequently observed with the slow pace of instruction conditions, overall, maintenance varied across conditions and participants.

Slow pace conditions produced the most efficient skill acquisition among the participants in this study. This finding contradicts earlier studies (Cariveau et al., 2016; Koegel et al., 1980; Neil & Jones, 2015; Roxburgh & Carbone, 2012). The participants' previous exposure to DTT may have influenced the optimal pace of instruction. Roxburgh and Carbone (2012) indicated that DTT was a component of their participants' programming. In contrast, the participants in the current study had no previous exposure to DTT. This lack of prior exposure to the reinforcement and extinction contingencies may have influenced the optimal pace of instruction results. Secondly, in this study, the interventionists engaged with the participants during the ISI. This strategy contradicts earlier methodologies found in pacing studies (Koegel et al., 1980). Further, Skinner and colleagues (1994) emphasized that strategies may be used during the ISI to increase appropriate responding. It is possible that the interventionists' engagement with the participants contributed to the increases in skill acquisition demonstrated during the slow pace conditions. Maintenance varied across each condition for the participants. The lack of consistent maintenance may have been, in part, related to the mastery criteria, which consisted of only four correct independent responses. In the future, including a mastery criteria in which the skills must be demonstrated over a longer period (i.e., several sessions), may potentially improve maintenance across the participants.

This study examined the impact of pace of instruction on skill acquisition for children with ASD or DS diagnoses. For all participants, the slowest pace of instruction (150 s condition) produced the most efficient skill acquisition. Although no studies have compared how pace affects learning for both children with ASD and DS, previous studies found no marked differences in the optimal pace of instruction among children with ASD and DS (Koegel et al., 1980; Neil & Jones, 2015; Roxburgh & Carbone, 2012). These results indicate that the most efficient pace of instruction may not correlate with a specific developmental disability. Further research should be conducted to examine the influence of the pace of instruction on skill acquisition during DTT across various diagnoses.

Strengths

The body of literature focusing on applications of ABA interventions for children with DS, although growing, is somewhat limited. Therefore, this study contributes to growing evidence supporting ABA interventions and specifically DTT to increase skill acquisition for children with DS. Additionally, there is little research exploring the effects of the pace of instruction on skill acquisition for individuals with DD; findings of this study may have implications for practice with children with DD as it highlights an effective and efficient method for identifying the optimal pace of instruction in DTT interventions.Finally, the procedural integrity of the intervention was high and is reflected in the mean ISI, which align with the intended timings for the ISI for each condition.

Limitations

This study was not without limitations. Although targets were randomly assigned to each condition, it is possible that differences in the level of difficulty across targets selected may have influenced the rate of skill acquisition. Secondly, the frequency of sessions changed as targets were mastered. Typically, the interventionists conducted each condition (e.g., one trial per 2.5 min, 2 min, 1 min, 40 s, and 30 s) during each day where sessions were scheduled. However, when other conditions were mastered, the interventionists delivered the remaining condition or conditions more than once per day, representative of more than one intervention session. Conducting a condition more than once per day impacted dose frequency, thereby potentially influencing the results (Neil & Jones, 2015). Third, baseline conditions were designed to assess responding at an ISI that did not mirror those in intervention to reduce carry-over effects, however, this prevents direct comparison of the responding in intervention to that of baseline. Future research should have each targets baseline ISI directly correspond to that of intervention. Fourth, for two participants, a compound stimulus (echoic+textual) was used as a prompt. Although there is research suggesting textual prompts may be more effective for teaching intraverbal responding (Finkel & Williams, 2001), the relative effectiveness of compound prompts is unknown. Finally, as the findings of this study were somewhat varied across participants and diverged from earlier research (e.g., Cariveau et al., 2016; Koegel et al., 1980), broad conclusions cannot be drawn regarding the optimal pace of instruction for learners with limited previous ABA experience.

Future Recommendations/Directions

Strategies implemented during the ITI, as well as an individual's previous learning history, should be considered during the development of a program. Skinner and colleagues (1994) noted that ITIs that include strategies to increase appropriate behaviours and decrease inappropriate behaviours may influence responding. Although strategies used by the interventionists during the ISI may have increased participant responding during the slow paced conditions, these strategies may only be considered anecdotally. Further, although multiple studies have evaluated the impact of modifying the duration of the ISI, no studies have examined the interventionists' responses during this time (Koegel et al., 1980; Neil & Jones, 2015; Roxburgh & Carbone, 2012; Skinner et al., 1994). Future studies should compare the influence of the interventionists' responding during the ISI (i.e., engaging or ignoring the participant) on participant skill acquisition. Additionally, the participant's history of exposure to DTT may have contributed to the discrepancies observed across studies (Roxburgh & Carbone, 2012). Future research should compare the influence of children's previous exposure to DTT when determining the optimal pace of instruction.

Key Messages From This Article

People with disabilities. You may learn various skills faster at different paces of instruction. Identifying the best pace of instruction for you and the skill you want to learn will have a positive effect on how quickly you learn the skill.

Professionals. Teaching strategies should be individualized to help people with disabilities learn in the best way possible. This study presents an effective methodology for determining the optimal pace of instruction for any child across any type of task.

Policymakers. Policies should continue to promote the individualization of strategies when teaching skills to children with developmental disabilities. This should include the incorporation of methodologies for selecting the optimal pace of instruction when teaching various skills to individuals with developmental disabilities.

References

Bauer, S., & Jones, E. A. (2014). A behavior analytic approach to exploratory motor behavior: How can caregivers teach EM behavior to infants with Down syndrome? *Infants and Young Children, 27*, 162-173.

Bauer, S., Jones, E. A., & Feeley, K. M. (2013). Teaching responses to questions to young children with Down syndrome. *Behavioral Interventions, 29*, 36-49. doi:10.1002/bin.1368.

Cariveau, T., Kodak, T., & Campbell, V. (2016). The effects of intertrial interval and instructional format on skill acquisition and maintenance for children with autism spectrum disorders. *Journal of Applied Behavior Analysis, 49*, 809-825.

Carnine, D. (1976). Effects of two teacher-presentation rates on off-task behavior, answering correctly, and participation. *Journal of Applied Behavior Analysis, 9*, 199-206.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson Education Inc.

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*, 519-533.

Engelmann, S., & Bruner, E. C. (1974). *Distar reading I and II.* Chicago, IL: Science Research Associates.

Feeley, K. M., & Jones, E. A. (2006). Addressing challenging behaviour in children with Down syndrome: The use of applied behaviour analysis for assessment and intervention. *Down Syndrome Research and Practice, 11*, 64-77.

Feeley, K. M., & Jones, E. A. (2008a). Preventing challenging behaviours in children with Down syndrome: Attention to early developing repertoires. *Down Syndrome Research and Practice, 12*, 11-14.

Feeley, K. M., & Jones, E. A. (2008b). Strategies to address challenging behaviour in young children with Down syndrome. *Down Syndrome Research and Practice, 12*, 153-163.

Feeley, K. M., & Jones, E. A. (2008c). Teaching spontaneous responses to a young child with Down syndrome. *Down Syndrome Research and Practice, 12*, 148-152.

Feeley, K. M., Jones, E. A., Blackburn, C., & Bauer, S. (2011). Advancing imitation and requesting skills in toddlers with Down syndrome. *Research in Developmental Disabilities, 32*, 2415-2430.

Finkel, A. S., & Williams, R. L. (2001). A comparison of textual and echoic prompts on the acquisition of intraverbal behavior in a six-year-old boy with autism. *The Analysis of Verbal Behavior, 18*, 61-70.

Fisher, W. W., Piazza, C. C., Bowman, L. G., & Amari A. (1996). Integrating caregiver report with a systematic choice assessment. *American Journal on Mental Retardation, 101*, 15-25.

Jones, E., Feeley, K., & Blackburn, C. (2010). A preliminary study of intervention addressing early developing requesting behaviours in young infants with down syndrome. *Down Syndrome Research and Practice, 12*, 98-102.

Jones, E. A., Neil, N., & Feeley, K. M. (2013). Enhancing learning for children with Down syndrome. In R. Faragher & B. Clarke (Eds.), *Educating learners with Down syndrome: Research, theory and practice with children and adolescents.* London, UK: Routledge.

Kodak, T., & Grow, L. L. (2011). Behavioral treatment of autism. In W. Fisher, C. Piazza, & H.

Roane (Eds.), *Handbook of applied behavior analysis* (pp. 229-249). New York, NY: Guilford Press.

Koegel, R., Dunlap, G., & Dyer, K. (1980). Intertrial interval duration and learning in autistic children. *Journal of Applied Behavior Analysis, 13*, 91-99.

Neil, N., & Jones, E. A. (2015). Studying treatment intensity: Lessons from two preliminary studies. *Journal of Behavioral Education, 24*, 51-73.

Roxburgh, C., & Carbone, V. (2012). The effect of varying teacher presentation rates on responding during discrete trial training for two children with autism. *Behaviour Modification, 37*, 298-323.

Skinner, C., Smith, E., & McLean, J. (1994). The effects of intertrial interval duration on sight-word learning rates in children with behavioral disorders. *Behavioral Disorders, 19*, 98-107.

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities, 16*, 86-92.

Sparrow, S. S., Cicchetti, D. V., & Saulnier, C. A. (2016). *Vineland Adaptive Behavior Scales—Third Edition (Vineland-3).* San Antonio, TX: Pearson.

Tincani, M., & De Mers, M. (2016). Meta-analysis of single-case research design studies on instructional pacing. *Behavior Modification, 40*, 799-824.

Urbaniak, G. C., & Plous, S. (2013). Research Randomizer (Version 4.0) [Computer software]. Retrieved from http://www.randomizer.org/

Zimmerman, I. L., Steiner, V, G., & Pond, E. (2011). *Preschool Language Scales- Fifth Edition (PLS-5).* San Antonio, TX: Pearson.