The Effects of Intertrial Intervals on Receptive Tasks for Young Children with Autism

By

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Abstract

Discrete trial teaching has been widely used to teach children with autism. A small number of studies have evaluated the effects of different lengths of intertrial intervals on the speed of learning and found that shorter durations of intertrial intervals appear to support faster learning. It is not clear, however, whether this is the case when using discrete trials to teach different tasks with different children. The purpose of this study was to conduct a systematic replication of the effects of intertrial intervals on receptive labeling by three children (ages 4 to 7 years old) diagnosed on the autism spectrum. A parallel treatments design was used to compare the effects of short intertrial intervals (5-10 seconds) to longer inter-trial intervals (15-20 seconds) during discrete trial teaching. Each participant was taught to point to pictures of objects, numbers, or people in response to the teacher's instruction. Each participant was taught a minimum of six pairs of receptive tasks, three taught with short intertrial intervals and three taught with long intertrial intervals. The results were mixed. One participant learned all of the pairs in roughly the same number of trials using both lengths of inter-intervals. The other two participants sometimes learned a pair of pictures with fewer trials using the short intertrial intervals and sometimes using the long intertrial intervals. While participants appeared to learn the tasks in a similar number of teaching trials, all participants learned the tasks in a shorter amount of total teaching time when the short intertrial intervals were used

Introduction

Autism is a developmental disability that is characterized by deficits in language and other social skills. These deficits can greatly impact the overall quality of life for a child with autism by creating barriers in learning and in developing meaningful relationships. There are, however, a number of studies that have demonstrated that deficits in language and social of young child with autism can be greatly reduced and, in some cases, apparently eliminated (e.g., Lovaas, 1987; McEachin et al., 1993). The procedures used in these studies have often been labeled as Applied Behavior Analysis or ABA and include a set of common elements: starting teaching early in the life of the child (e.g., two to five years old), intensive teaching (e.g., 30-40 hours of teaching each week), use of teaching procedures based on research in the principles of learning, and systematic teaching of communication and other social skills.

One of the most prominent characteristics of ABA teaching is the use of discrete trial teaching (DTT) especially during the initial intervention efforts. The components of a discrete trial include an instruction by the teacher (e.g., "point to the truck"), some type of prompt by the teacher early in teaching, the child's response, a consequence for the child when he/she touches the truck (e.g., "That's right!" said enthusiastically and 5 seconds in which to play with the truck), and a brief pause between the consequence and the next instruction (the intertrial interval).

Thus, the basic elements of a discrete teaching trial are: (1) an instruction or action on the part of the teacher (e.g., "Point to the red card"); (2) a prompt or assistance from the teacher (e.g. physical assistance, pointing towards the correct response) to help the person being taught to make a correct response (over teaching trials the prompts are gradually removed); (3) a response from the person who is being taught (e.g., the person points to the red card, or points to

another card, or does not respond within a short period of time); (4) a consequence provided by the teacher (e.g. the teacher says “Right” and provides sip of orange juice for a correct response, or teacher does not respond or says “No” for an incorrect response); and (5) a pause before the next teaching trial is initiated (called an intertrial interval).

Despite the common use of discrete trial teaching, there has been little research evaluating the effects of the individual elements of discrete trials. For example, most teachers who use discrete trial teaching use their best judgment as to when to deliver an instruction, how long the learner has to respond, how frequently consequences should be delivered, whether “No” following an incorrect response should be used or not, and the amount of time there should be between the end of one discrete trial and the next discrete trial. The purpose of this study is to review briefly the research literature available about the five elements of discrete trial teaching and, then, to conduct a systematic replication of a small number of studies that suggest learning is more rapid when using short intertrial intervals than when using longer intertrial intervals.

Prompting

Prompting is a term used to label something the teacher does prior to a child’s response that is designed to improve the likelihood that the child’s response will be correct. Two general types of prompts have been used: *extra stimulus* prompting and *within stimulus* prompting. Methods of extra stimulus prompting refer to events that the teacher does just before the child responds such as providing physical assistance toward the correct stimulus, modeling by picking up the correct stimulus, placing the correct stimulus item closer to the child than the other stimulus item, and gesturing towards the correct stimulus item. If these extra prompts are effective, then they are gradually removed so that the child eventually learns to make correct responses without the "extra” help from the teacher. *Within stimulus* prompting refers to making

the stimulus choices, initially, physically different enough so that the child can make the correct responses simply on the basis of the initial differences in the stimuli. If this is effective, then the added differences between the stimuli are gradually removed so that the child eventually learns to make the correct responses without the added differences between the stimuli.

Within stimulus prompting versus trial-and-error procedures

An example of within stimulus prompting is as follows. Assume that a student is being taught to point to pictures of two different kinds of birds such as a sparrow and a robin. In this teaching, sometimes the teacher asks the student to "touch sparrow," and sometimes the teacher asks the student to "touch robin." One approach to help the student to make a correct response is to initially make the pictures of the sparrow and the robin very different (e.g., make the robin very large in comparison to the sparrow). Thus, the student is more likely to be correct in distinguishing the two stimuli and to be reinforced. Over teaching trials, the differences between the two pictures, such as size, are gradually reduced so that the student is likely to continue to be correct (and be reinforced). Eventually the pictures will share many common characteristics and are only distinguishable by the "real" characteristics that are different between the two birds (e.g., shape, coloring, size). This process is generally referred to as "within stimulus" prompting.

The effectiveness of within stimulus prompting has been compared in two studies to the effectiveness of trial-and-error teaching where the stimuli remain the same during teaching and the students are simply reinforced for correct responses and not reinforced for incorrect responses.

Griffiths and Griffiths (1976) provided an early example of evaluating the effectiveness of within stimulus prompting as compared to trial-and-error teaching. The participants were six children with autism who were four or five years old. The teaching task for the children was to

distinguish between the letters “p” and “q” during some teaching trials and between “d” and” b” during other teaching trials. In the within stimulus prompting procedures, the stimuli were manipulated by adding an additional picture cue to one of the letters. For example, the picture of a dog was placed next to the letter “d”. Gradually, over teaching trials, the picture of the dog was changed to a smaller size of dog, then the outlines of the dog were made lighter and lighter, then the outlines of the dog were “masked” by placing a black rectangle over picture of the dog, then the black rectangle and outline of the dog were gradually removed until only the “d” remained. In this study, all of the children were able to learn all of the letter discriminations with all of the letters. The children, however, made fewer total errors and required fewer teaching trials to meet criterion when using the within-stimulus teaching procedure than when using the trial and error teaching.

Schilmoeller, Schilmoeller, Etzel and LeBlanc (1979) compared the effectiveness of two different types of within-stimulus prompting procedures to trial-and-error procedures in teaching typically developing preschool-aged children to distinguish between different pictures. One type of within-stimulus prompting was labeled as stimulus “shaping” by the authors. In the stimulus “shaping” procedures, the authors presented two different pictures to the children (i.e., an apple with a worm and a tree on a hill) and told the children to point to the “point to the picture that earns tokens.” Over teaching trials, the shapes of the pictures were gradually changed into a circle (the “apple”) or a triangle (the “tree”) with a horizontal line on each side. The other type of within-stimulus prompting was labeled as within-stimulus “fading”. In the within-stimulus “fading” procedures, the authors presented two different pictures to the children (a circle with short horizontal lines on either side outlined in thick dark lines and a triangle with short horizontal lines on either side outlined in thin dark lines) and told the children “point to the

picture that earns tokens." During teaching, the thickness of the lines of the circle were gradually reduced until the thickness of the outlines of both figures were the same.

The typically developing preschool children were divided into three groups: one group of 16 children was taught with a within-stimulus "shaping" procedure (gradual removal of the picture of the apple and worm); one group of 16 children was taught with a within-stimulus "fading" procedure (gradual removal of the thickness of the lines of the circle and horizontal lines); and one group of children was taught with trial-and-error procedures. The results of the study were mixed. Overall, the children who were taught using the within-stimulus "shaping" procedure did the best: students taught in this group met the mastery criterion most frequently and had fewer errors during teaching. Children who had trial-and-error teaching met the mastery criterion less frequently than children who had the within stimulus "shaping" procedure, but more frequently than the stimulus "fading" group. Additionally, the number of errors made by the trial-and-error group was more than the within stimulus "shaping" group, but less than the stimulus "fading" group.

Thus, some of the literature available suggests that certain types of within-stimulus manipulations (stimulus shaping) are more effective than traditional trial-and-error procedures in teaching discriminations to both typical and atypical children. The literature also indicates that other types of within-stimulus prompting (stimulus fading) are less effective than trial-and-error procedures. It is difficult to make strong conclusions, however, due to the limited amount of research available.

Within-stimulus prompting versus extra-stimulus prompting

Earlier, we defined within-stimulus manipulations as gradual changes in the stimuli displayed to the students and extra-stimulus prompting as the use of additional prompts such as physical guidance, modeling, and gestures to get the student to respond correctly. There is a modest amount of research comparing the effectiveness of within-stimulus prompting and extra-stimulus prompting.

Wolfe and Cuvo (1978) compared within-stimulus prompting procedures to extra-stimulus prompting procedures to teach difficult letter discriminations to 24 adult participants with developmental disabilities. The participants in this study were taught to discriminate the letters V, U, N, H, C, and O. These letter discriminations are typically hard to learn because they vary only slightly in shape. For example, the distinction between an O and a C, is only that an O is completely closed while a C has an opening on one side. The authors used within-stimulus prompting in which the critical differences of the letters were highlighted by increasing the size and width of the letters. For example, when teaching the distinction between a V and a U using the within-stimulus prompting procedure, the thickness of the angle of the letter V was increased to emphasize the point of the V (critical feature) and then the thickness of the lines were thinned across trials. In the extra-stimulus prompting, the letters were presented as they were typically written (e.g., the letter V did not have any adjustments to the thickness of the lines) but the teacher pointed to the correct picture. For example, the teacher said “touch the V”, immediately pointed to the correct card, and then waited for the participant to respond. The results were that participants who were taught using the within-stimulus procedures learned more letters and required fewer trials to mastery than did participants taught using the extra-stimulus prompting procedure.

Summers, Rincover, and Feldman (1993) compared the use of within-stimulus prompting and extra-stimulus prompting to teach four children with developmental disabilities to discriminate between the prepositional concepts of "in" and "on". In this task, the teacher placed an object in front of the child on the table (e.g., a cup), handed the child an additional object (e.g., spoon), and instructed the child to place the item either "in" or "on" the object placed on the table. Additionally, as the teacher gave the instruction, the teacher said, for example, "on" in a louder voice and repeated it three times (e.g., "on", "on", "on"), as compared to the other target instruction (e.g., "in") which was said in a neutral voice only once. During the within-stimulus prompting, the number of times the instruction was repeated was faded across successful trials until it was said only once, then the loudness of the instruction was faded to the neutral voice. In the extra-stimulus prompting condition, a physical prompt (e.g., modeling, pointing, positioning of the target closer, and/or physical guidance) was added. Instructions were delivered in a neutral voice for all targets and instructions were not repeated. For example, the teacher would say "on" only once and in a neutral voice and then physically guide the child's hand to the correct stimuli. The type of extra-stimulus prompt (e.g., pointing, positioning, and physical guidance) varied according to what physical prompting the child responded to best. The children were exposed to the extra-stimulus procedures first and then to the within-stimulus conditions. The results showed that the four children did not meet mastery criterion with extra-stimulus prompting. When within-stimulus prompting was introduced, all four of the children quickly met mastery criterion. The authors suggest that within-stimulus prompting was more effective in teaching children to discriminate between two prepositional phrases than the use of extra-stimulus prompting, It was not clear, however, why the vocal cues were more "within" the stimuli than

were the pointing or physical prompts. Additionally, the sequencing of the instructions may have affected the outcomes.

Schreibman (1975) compared the effectiveness of a within-stimulus prompting procedure to an extra-stimulus prompting procedure to teach six children with autism to point to various abstract pictures. For example, the children were taught to point to a picture of an arm pointing upward or downward. Initially, two drawings of stick figures were placed in front of the child: one stick figure had the arms pointing downward and the other had arms that slanted upward. In the within-stimulus prompting procedure, the outlines of the arms were bolded and over trials the stick figures were gradually removed until the final pictures were a picture of two arms pointing downward and a picture of two arms pointed upward. In the extra-stimulus condition, the pictures used in the final step of fading in the within-stimulus prompting procedure (a picture of downward pointing arms or a picture of upward pointing arms) were presented, the teacher pointed to the correct response immediately following the instruction, and the child had the opportunity to respond. No picture fading was used during the extra-stimulus prompting procedure. As the child responded correctly, the teacher's pointing gesture was faded out. The results showed that the extra-stimulus procedure was unsuccessful in each instance it was applied to new tasks whereas the within-stimulus fading procedure was successful 15 out of 16 times it was applied to new tasks for the children.

Different extra-stimulus prompting procedures

In addition to comparisons of within-stimulus prompting to extra stimulus prompting, the effectiveness of a variety of types of extra-stimulus prompting procedures (e.g., gestures, models, and physical prompts) have been evaluated.

Godby, Gast, and Wolery (1987) taught three children with intellectual disabilities to touch various objects by when the teacher asked them, for example, to touch a ball. The authors compared a time-delay prompting procedure (using a model as a prompt) to a least-to-most prompting procedure (using four types of prompts). In the time-delay prompting procedure the teacher demonstrated the correct response by pointing to the object. Initially, the teacher pointed to the correct object prior to the child's response. Later on in teaching, the teacher pointed to the correct object only if the child did not make a correct response within five seconds of the teacher's instructions. In the least-to-most prompting procedure, four different prompting techniques were used: the least intrusive prompt (an instruction) was used followed by an instruction plus model, instruction plus a partial physical prompt, and an instruction plus a full physical prompt if earlier prompts did not produce a correct response. Although both prompting procedures were effective, the time-delay procedure using a model produced fewer errors, required fewer sessions, fewer trials, and less time to reach a criterion performance than the least-to-most prompting procedure.

Ault, Wolery, Gast, Doyle, and Eizenstate (2008) conducted a similar study several years later. In this study, two children with autism were taught to name numbers using a verbal modeling time-delay procedure and a least-to-most prompting procedure that included four different levels of prompting (i.e. instruction alone, instruction plus written prompt, instruction plus visual prompt, instruction plus verbal prompt). The results showed that the verbal modeling time-delay procedure was more efficient than the least-to-most prompting procedure. Additionally, the time-delay procedure with verbal prompts took a smaller number of sessions to meet criterion performance, produced fewer errors, and required less instructional time.

Riesen, McDonnell, Johnson, Polychronis, and Jameson (2003) compared the effects of a time-delay procedure and a simultaneous prompting procedure to teach four teenage children with developmental disabilities various scientific terms and definitions. In the time-delay procedure a model prompt was used and in the simultaneous prompting procedure a gesture prompt was used. The results showed that two participants learned more rapidly with the time-delay procedure using a model while the other two participants learned more rapidly with the simultaneous prompting procedure using a gesture prompt.

Kurt and Tekin-Iftar (2008) compared a simultaneous prompting procedure to a delayed physical prompting procedure to teach four children with autism to turn on a CD player and take a picture with a digital camera. Tasks were broken down into steps and the teachers prompted each step until the chain was complete. The results were mixed. The delayed prompting procedure required fewer trials and less time to learn the task for two participants whereas the other two participants required fewer trials and less time using the simultaneous prompting procedure.

The literature comparing time-delay procedures to least-to-most prompting have indicated that both can be effective in teaching, but that modeling time-delay procedures required fewer trials, created fewer errors, and took less teaching time to reach mastery (Ault et al., 1987; Berkowitz, 1990; Godby et al., 1987). When a time-delayed prompting procedure was compared to a simultaneous prompting procedure, however, the literature indicates mixed results in effectiveness and efficiency.

Consequences

Manuals that provide guidelines for the implementation of discrete trial teaching often contain many suggestions about what consequences should be used in teaching and how to implement consequences to ensure learning and sustained responding. For example, guidelines suggest how to select reinforcers (e.g., Fisher, Piazza, Bowman, & Amari, 1996; Fisher et al., 1992), pair neutral reinforcers with naturally occurring reinforcers (e.g. to create new conditioned reinforcers), and use schedules of reinforcement and immediacy of reinforcement to maintain high rates of responding. On the basis of both basic and applied research studies, these guidelines seem reasonable. There are, however, only a very limited number of studies that have examined the effects of different ways of selecting and providing consequences during discrete trial teaching with children with autism.

Newman, Needelman, Reinecke, and Robek (2002) evaluated the effects of teacher choice of reinforcement and task order versus child choice of reinforcement and task order during discrete trial teaching. In this study, three children with autism (ages seven to twelve) were taught to touch various colors, objects, and shapes when instructed (e.g., "touch blue") and to name label letters and shapes when asked, "What is this?" On the days when students chose the reinforcement and the order of the tasks, the teacher asked the child, "What would you like to work for today?" and then asked the child, "What program would you like to do first?" The child was asked to pick a new reinforcer after the completion of each program. On the days that the teacher selected the reinforcers and the order of the tasks, the teacher stated, "First we are going to do X (e.g., handwriting) and you can earn X (e.g. spinning toy)." During teaching, the following behaviors were recorded: correct and incorrect responding, escape attempts, gaze avoidance, perseverative laughing, and aggression such as scratching and kicking. The results indicated that there was no difference in correct responding between teacher-selected or student-

selected conditions, however, lower levels of undesirable behaviors were observed when the students selected the consequences of their behavior and the order in which the tasks were taught.

Koegel, Schreibman, Britten, and Laitinen (1979) evaluated the effects of changing the schedule in which reinforcement was delivered during discrimination training. Twelve children with autism were taught to discriminate between two different pictures. During teaching, the teacher placed two different picture cards in front of the child and said, "Point to the correct card." When a child pointed to one of the cards that had been arbitrarily predetermined as the "correct" card, the child received a small portion of food (e.g. raisin) and verbal praise. All correct responses during the pre-training received reinforcement. Next, a procedure was implemented in which the children were exposed to a continuous reinforcement condition and a variable ratio reinforcement condition. In the continuous reinforcement (CRF) procedure, every correct response was reinforced. In the variable ratio (VR) schedule, an average of one out of three correct responses were reinforced. In both schedules, the reinforcers were a portion of food and verbal praise. The results showed that correct children's responding was at higher percentage levels with a VR schedule of reinforcement than with a CRF schedule of reinforcement.

Charlop, Kurtz and Milestein (1992) evaluated the effects of interspersing mastered tasks in conjunction with manipulating the schedule of reinforcement to teach various instructions to five children with autism. The acquisition tasks that were taught to the children included raising their arms, touching their arm, point to left and right arms, and placing items "next to" one another. The mastered tasks that were interspersed among the acquisition tasks had been previously taught to a level of 80% or higher correct responding. During teaching, acquisition tasks and mastered tasks were interspersed, meaning that the teacher could ask both types of

tasks within the same teaching session. Throughout the study, children received a small portion of food and verbal praise for every correct response on acquisition tasks. In the first phase, children received a small portion of food and verbal praise following every third correct response on previously mastered tasks, whereas, the children received a small portion of food and verbal praise following every correct response for a new acquisition task. In the second phase, the children did not receive any praise or food for correct responses on previously mastered tasks, whereas every correct response on acquisition tasks produced a small portion of food and verbal praise. In the third phase, every correct response on a mastered task produced verbal praise-only and every correct response on an acquisition task resulted in both food and verbal praise. The results showed that when acquisition and mastered tasks received the same reinforcement (i.e. praise and food) but on different schedules (e.g., every three correct responses versus every response), all children failed to meet mastery criterion on acquisition tasks. When access to food was given only contingent on acquisition tasks, and mastered tasks only produced praise, all of the children met mastery criterion. These results suggest that the type of reinforcement delivered may affect behavior rather than the schedule on which it is delivered.

The literature examining the effects of different ways of selecting and providing consequences during discrete trial teaching with children with autism has produced some interesting results. A child's choice in the type of reinforcer and task does not appear to affect correct responding, but does, however, appear to lower the level of undesirable behavior during teaching. When reinforcement schedules were manipulated, a variable-ratio of reinforcement produced higher levels of correct responding than did a continuous method of reinforcement when only acquisition tasks were included in teaching (Koegel, Schreibman, Britten, & Laitinen, 1979). When mastered tasks were interspersed into teaching, the type of reinforcement provided,

not the schedule, increased correct levels of responding (Charlop, Kurtz and Milestein, 1992). The limited literature suggests that manipulating the reinforcement procedures during discrete trail may be a method to increase correct responding and reduce undesirable behaviors during teaching.

An area of discrete trial teaching that has received little attention in the literature is the use of various intertrial intervals. A small number of studies have evaluated the effects of short and long intertrial intervals on learning and problem behavior of children with and without autism. While the small body of research suggests that the short intertrial intervals may produce higher levels of learning and lower levels of problem behavior, there are some limitations of this literature that may warrant further discussion.

Intertrial intervals

During discrete trial teaching there is a period of time following a correct response of the child during which the teacher often delivers some type of consequence (e.g., praise and perhaps an edible or an opportunity for the child to play with a favorite toy). If the child's response was incorrect, there may be no consequence or the teacher may say "no" or "that's not the dog" (for example). Following this, a new trial is started. The interval between the child's response and when the teacher starts the next trial is referred to as the intertrial interval. Only a limited amount of research has been conducted on whether the length of intertrial intervals affects learning during discrete trial teaching, despite the fact that this is an issue often discussed by teachers. The discussion typically arises because it is sometimes noted that children with autism engage in self-stimulatory behavior during intertrial intervals and teachers wonder whether the self-stimulatory behavior interferes with learning on the next teaching trial.

Carnine (1976) manipulated the intertrial intervals during the teaching of two low-achieving children with various verbal skills. The children were taught to vocally sound out letters (e.g. "a" sounds like "aahh"), blend sounds (e.g., "bb-aah") and to sound-out a word at a normal rate with verbal models and prompts. In some teaching sessions a short intertrial interval was used during which the teacher acknowledged a correct response by saying "right" and then immediately presented the next trial. If child made an incorrect response, the teacher provided a verbal model of the correct answer and then immediately presented the next trial. In other teaching sessions the teacher used a longer intertrial interval in which the teacher acknowledged correct or incorrect response in the same way but silently counted to five before presenting the next trial. The author recorded correct and incorrect responding and off-task behavior such as a child walking around and jumping or vocal behaviors such as crying, talking, and screaming. The results were that short intertrial intervals produced higher percentage of correct responding and less off-task behavior than did the longer intertrial intervals.

Koegel, Dunlap and Dyer (1980) similarly investigated the possible differences produced by short and longer intertrial intervals with three children with autism during the teaching of skills typically taught in the regular clinical treatment program. The tasks included instructions to do a variety of activities such as sequencing items (e.g., "give me the red, then blue, then black" when presented with different blocks), verbal imitation (e.g., "say ah"), touching, moving, and naming objects (e.g., "touch boot," "give me three spoons," "what is this"), and placing objects in relation to other objects (e.g., "put the pencil under the book"). Short intertrial intervals (1-4 seconds from the end of one trial to the next) and longer intertrial intervals (4-26 seconds) were used when teaching. First, teaching was done with the longer intertrial intervals. After that, short intertrial intervals were used. All of the children showed an increase in correct responding when

they moved from longer intertrial intervals to short intertrial intervals. Next, the authors use a reversal design to further evaluate the possible different outcomes of the short intertrial intervals over the longer intertrial intervals. The results showed essentially the same: the children produced a slightly higher percentage of correct answers when the short intertrial intervals were used. The authors also anecdotally noted that the children engaged less in "stereotypic" behavior when the teaching was done with short intertrial intervals.

Dunlap, Dyer and Koegel (1983) followed up their previous research by evaluating whether short and long intertrial intervals not only affected the percentage of correct responding but also affected the amount of self-stimulatory behavior with three children with autism. In this study, the short intertrial intervals averaged one to two seconds (and were always less than 4 seconds), and the long intertrial intervals were always more than 5 seconds (but varied in length from 5 seconds to 26 seconds). The results of the study were similar to that of the previous study: the short intertrial intervals produced lower amounts of self-stimulatory behavior and higher percentages of correct responding when teaching.

The research on the effects of intertrial intervals for children with autism, suggest that short intertrial intervals produce higher percentages of correct responding than long intertrial intervals and that short intertrial intervals decrease off-task and stereotypic behaviors in children. There are, however, only three studies available supporting these conclusions; the same children participated in two of the studies and the range of interval size varied considerably for short (1 to 4 seconds) and long (5 to 26 seconds) intervals. Nevertheless, it is an issue that should be investigated further because the possible benefits of using short intertrial intervals may be substantial. The purpose of this study was to compare the efficiency and effectiveness of trials presented using a short intertrial interval (5 to 10 second) and a long intertrial interval (15 to 20

second) on skill acquisition as well as the effects of the two intertrial intervals on problem behavior for children diagnosed with an autism spectrum disorder.

Method

Participants

The three criteria for selecting participants were: a diagnosis on the autism spectrum, age between 2 and 8 years old, and deficits in receptive language skills. Various areas of deficits in receptive language skills were provided by parents and then tested in pre-teaching assessments .

Elliot was a 7-year old boy who attended a public elementary school and had paraprofessional supports while he was in class. Elliot was diagnosed with PDD-NOS by a physician. During the time of the study, Elliot was not being formally taught receptive language. He spoke in some sentences, engaged in limited conversational speech, and answered some questions. Elliot also engaged in stereotypic behaviors such as hand flapping and "scripting" (e.g., reciting the morning school announcements from several days ago in inappropriate contexts). He was reported to be non-compliant, but this occurred infrequently during the study.

Patrick was a 4-year old boy who was receiving approximately 35 hours weekly of early intensive behavioral intervention. Patrick was diagnosed with autism by a physician and psychologist.The primary focus of his early intervention services was on developing his receptive and expressive language skills, self-care skills, and play skills. At the time of the study, Patrick imitated simple words and phrases but did not label objects, people, or activities unless he was prompted by the teacher modeling the label. Patrick engaged in multiple stereotypic behaviors: unusual hand movements in front of his face, eye fluttering, spitting, screaming, and laughing at inappropriate times.

Hailey was a 4- year old girl who was receiving approximately 30 hours each week of intensive behavioral intervention. Hailey was diagnosed with autism by a physician and psychologist.The primary focus of the intervention was improving her pronunciation of words and phrases, increasing her basic communication skills, and increasing her basic self-care skills so that she could transition into a typical preschool classroom with supports. Hailey engaged in stereotypic behaviors such as singing at times that were not appropriate, moving her fingers across her face, and having "conversations" with people using her fingers as puppets.

Setting

For Patrick and Hailey, teaching sessions were conducted in a small classroom that contained a child-sized table and two chairs. For Elliot, teaching sessions were conducted in his home at the dining table. During all teaching sessions, children sat next to the teacher so that each child could see the stimuli and hear instructions.

Selection of Materials

Pictures approximately 3.5 by 5 in were presented to each participant in triads in a picture assessment session. Each of the pictures tested was presented in an unsystematic order and the teacher asked the child to touch each of the pictures three times during each assessment session. Pictures to which a child responded correctly 33% of the trials or less were selected for teaching. These pictures were then randomly paired with each other and the picture pairs were randomly assigned to either the short or the long inter-trial interval condition. All pictures that had 33% or less correct responding during assessment sessions, and were not assigned to either of the intertrial interval conditions, were used as distractor cards during teaching. Six pairs of pictures were selected to teach to Elliot, a different set of six pairs of pictures were selected to teach to

Hailey, and another different set of eight pairs of pictures were selected to teach to Patrick. As indicated in Table 1, Elliot was taught to touch pictures of addition facts, Patrick was taught to touch pictures of household items**,** and Hailey was taught to touch pictures of the occupations of people who were dressed in different occupation apparel. A timer was used to measure the length of time between teaching trials (intertrial intervals).

The Teaching Task

Each child was taught to either touch pictures of addition facts, household items, or occupations of people. A teaching trial started when the teacher put three pictures down on the table from left to right. Two of the pictures placed in front of the child were the target pair to be taught. The third picture was never taught and was included to decrease the likelihood that a child would be reinforced for randomly touching any picture. Once the pictures were all placed on the table, the teacher said, "Look" to the child and then pointed to each of three picture cards. The teacher continued to point to each card until the child looked at each card. The teacher then said, for example, "Touch the spoon." If the first picture the child touched was the spoon and it was touched within 5 seconds after the teacher's request, the teacher praised the child (e.g., "Great!" or "Super!"), gave two tokens to the child, and either tickled the child briefly or exchanged a "high-five" with the child. If the first picture that the child touched was an incorrect picture, or if the child did not touch any of the pictures within 5 seconds of the teacher's request, the teacher prompted a correct response from the child by touching the correct card. This procedure paralleled a prompting procedure used by Worsdell et al. (2005). After the child made a correct prompted response, the teacher gave one token to the child and praised the child (e.g., "That's right," or "Good job").

The Reinforcement System

We asked the parents of the children what toys and activities their children liked to play and what things they liked to eat. We also directly observed the children playing with toys, selecting food, and engaging in activities. On the basis of the recommendations of the parents and our observations of the children playing and eating, we selected a variety of toys, activities, and edibles. We then conducted a stimulus preference procedure (multiple stimuli without replacement) to select the most preferred toys, foods, or activities for each child (DeLeon & Iwata, 1996). We displayed a minimum of 15 various toys, objects, and edibles and allowed each child to select one item from the assortment and have access to it for one minute. At the end of one minute, we removed the item initially selected by the child, displayed the remaining items, and allowed the child to select another item and have access to it for one minute. This was repeated until all items had been selected or until the child did not show interest in any the remaining items. For each child, the teacher conducted four preference assessments (two times each on two different days). Based on the order in which each child selected the toys, edibles, and objects associated with activities, we divided the items into three categories: the most preferred (top 33% of items), the moderately preferred (the next 33% of items), and the least preferred (lowest 33% of items).

During teaching, children earned tokens for touching the pictures that the teacher requested. During both short and long intertrial interval teaching sessions, each child was exposed to 20 teaching trials with each intertrial interval and received tokens and praise for correct responding. The minimum number of tokens that could be earned by a child was 20 and the maximum number of tokens earned was 40. If, at the end of either the short or the long intertrial interval teaching session, a child earned only 20 tokens, then the child could choose an

item from the least preferred items and have access to it for one minute. If a child earned 21 to 30 tokens, then the child could choose an item from the moderately reinforcing items and have access to it for one minute. If a child earned 31 to 40 tokens, then the child could choose an item from the most preferred items and have access to it for one minute. To make it clearer to the children how many tokens they were earning during teaching, the first 20 tokens were put on a purple sheet of paper, nine tokens were put on a red sheet of paper, and any greater number of tokens were put on a pink sheet of paper.

After teaching had been conducted for 11 teaching sessions, one participant, Hailey, seemed disinterested in the toys and activities that we provided as reinforcers (refer to Table 9 and Figure 3). So, for Hailey, we modified the reinforcement system for both the short and the long intertrial interval procedures. Hailey's most preferred reinforcers were puzzles. So, before each teaching session, Hailey selected a puzzle she would like to complete. During teaching, each time Hailey made an unprompted correct response she was given a puzzle piece to put into the puzzle, verbal praise, and some form of physical touch (e.g. high-five, tickles). Hailey then put the puzzle piece in the proper place within 5 seconds or was assisted by the teacher to put the puzzle piece in the proper place within 5 seconds. If the instructor had to prompt Hailey to touch the correct picture, she received only a verbal praise statement (e.g. "nice job," "well done").

Experimental sessions

Experimental sessions were conducted two or three times a week for each child, based on the availability of the child. First, a probe session was conducted prior to teaching each day. The purpose of the probe sessions was to evaluate the children's performance in pointing to pictures in the absence of teacher prompts and any immediate consequences for their behavior. After a

probe session was conducted, a teaching session followed. During each teaching session, a child was taught to touch pictures from two pairs of pictures. One pair of pictures was taught exclusively with short intertrial intervals (5 to 10 seconds between teaching trials) and the other pair of pictures was taught exclusively with longer intertrial intervals (15 to 20 seconds between teaching trials).

Baseline. To determine which pictures the children already correctly touched when asked to do so, the teacher asked each of the children separately to touch a number of pictures in three assessment sessions. During each assessment session, the teacher put out three cards on the table and instructed the child, "Touch the [item]." No additional instructions or prompts were given and there were no consequences provided following a child's response (or nonresponse). Pictures that the child did not point to correctly over 33% of the time were randomly selected to be taught in a set of three pictures. Thus, three pictures were displayed to a child on each trial (two pictures to be taught and one distracter picture).

Daily probes. Prior to each teaching session, we conducted daily probes. During the daily probes, each of the sets of three pictures being taught (those taught with short intertrial intervals and those being taught with long intertrial intervals) were presented an equal number of trials in an unsystematic order for 16 trials (four times for each card). The pictures were presented as they were during teaching (the teacher put three pictures on the table, said "Look" to the child and then said, for example, "Touch spoon"). There were, however, no consequences for the child's behavior. Approximately 1 second after the teacher asked the child to point to a picture and the child responded by touching any of the cards or did not touch any card within 5 seconds after the teacher's instruction, the next trial started. The mastery criterion was 100% correct responding across three consecutive probe sessions for both pictures of a teaching pair.

When the mastery criterion was met, the mastered pair was no longer presented during teaching sessions. If one pair reached the mastery criterion before the other, the non-mastered pair was taught during three additional teaching sessions of 20 trials each conducted on three consecutive teaching days (a total of 60 additional trials) to determine of the mastery criterion could be met with a small amount of more teaching.

Full Probes. We conducted full probe sessions prior to teaching any target pairs to establish baseline performance and, subsequently, whenever a child met mastery criterion for a pair of pictures (100% correct responding to both pictures of a pair during three consecutive daily probe sessions). As in daily probes, the teacher did not provide any prompts nor were there any immediate consequences for behavior. In full probes, however, all pictures taught or to be taught to a child were presented. In the full probes, the teacher presented trials in the same way as in teaching: the teacher put three pictures on the table and instructed the child to touch one of the pictures by saying, for example, "Touch the spoon." When the child touched the correct card, an incorrect card, or did not respond within 5 seconds, the next trial started. Due to the length of each full probe session, participants received a short play break (approximately 30 seconds) every 12 to 15 trials.

Teaching Sessions. As described earlier, at the beginning of each teaching session, a daily probe was conducted to test the children's current level of accuracy in touching the pictures requested. Prior to the beginning of each teaching session, the teacher randomly determined whether teaching would start with the pair of pictures assigned to short intertrial intervals or the pair of pictures assigned the long intertrial intervals. In either case, the child was first taught 20 consecutive trials (ten for each picture of a pair randomly sequenced) with the pictures that had been selected to be taught using either the short or the long intertrial intervals. Following this, the

child was allowed to play for one minute with a preferred toy or engage in a preferred activity that he or she had exchanged for their earned tokens during the preceding 20 teaching trials. Then, for 5 to 10 minutes, the child could go for a walk or engage in an activity that was not selected during the reinforcer preference assessment. Finally, the child was taught a second pair of pictures for 20 consecutive trials (ten for each picture randomly sequenced) using the same presentation and consequences as were used for first 20 teaching trials but with the alternative intertrial interval size.

Prior to every third teaching session, we attempted to evaluate each child's preference for the short or the long intertrial intervals. To do this, the child was shown three colored mats. One mat was colored the same as the mat used during teaching with short intertrial intervals. Another mat was the same color as the mat used during teaching with long intertrial intervals. The third mat was not associated with either the short or the long intertrial intervals. We simply asked each child which mat they wanted to use for the first of the two teaching conditions. If the child chose a mat associated with either the short of the long intertrial interval conditions, that mat and the associated short or long intertrial interval procedures were used. If the child chose the mat that was not associated with either the short or the long intertrial intervals, the teacher randomly selected whether the short or the long intertrial interval procedures would be used first. Thus, the teaching sessions immediately followed the daily probe. Whether the short intertrial condition or the long intertrial interval condition was implemented first, was determined randomly, except when each child was given the opportunity to choose which condition was implemented first.

Behaviors Measured and Reliability of Measures

The teacher recorded the following behaviors of each child during all teaching and probe sessions: correct responses, prompted correct responses, incorrect responses, and what color

mats each child selected when he or she had an opportunity to determine whether the first teaching period of the day would be using short or long intertrial intervals.

The teacher also recorded the stereotypic behaviors of the children for a randomly selected 25% of teaching sessions. As indicated in Table 2, stereotypy was defined for each participant. Elliot engaged in scripting, which was defined as any instance in which Elliot vocalized and was not oriented toward researcher and the content was not relevant to ongoing teaching. The end of a vocalization is when there were no vocalizations for 2 seconds. Patrick engaged in spitting, which was defined as any instance, in which Patrick pursed his lips, blew air out of his mouth with a clear audible sound and then returned his lips to their original positioning. Hailey engaged in "finger puppets" which was defined as any instance in which Hailey "walked" her fingers across the table or vocalized and simultaneously held fingers as if they were puppets or wiggled her fingers in front of her face. The end of behavior was noted when there was an absence of any of these finger behaviors for 2 seconds.

Finally, the teacher recorded her own behavior in presenting pictures and delivering consequences to the children during all teaching and probe sessions. These teacher behaviors were: random placement of the target pictures on the table to start a teaching or probe trial; saying "look" while pointing to the pictures on the table; saying the instruction (e.g., "touch the spoon"); delivering two tokens, a praise statement, and a physical touch to the child after a correct response; delivering a prompt after an incorrect response of the child or no response within 5 seconds of the instruction; delivering one token and verbal praise after a correct prompted response; and initiating a new trial following the end of the preceding trial with an intertrial interval of either 5 to10 seconds or 15 to 20 seconds. All of the teaching and probe sessions were video recorded. To determine the reliability of the measures collected by the

teacher, an independent observer recorded the same behaviors as did the teacher from a randomly selected sample of 30% of the video recordings.

The reliability between the teacher and the independent observers was evaluated by looking at each teaching or probe trial and scoring the presence or absence of each of the teacher and child behaviors listed above (with the exception of self-stimulatory behavior). So, for example, on the first teaching trial examined, the teacher and an observer scored whether each of the elements of the teaching trial were or were not presented in the order specified, and they scored whether the child's response was correct, prompted correct, or incorrect. Point-by-point reliability calculations were used for child and teacher behaviors. This calculation consisted of adding the total number of agreements divided by the number of agreements plus disagreements, multiplied by 100 to obtain a percentage. For Hailey the frequency and the duration of her stereotypy behaviors were recorded and for Elliot and Patrick the frequency of their stereotypy behaviors were recorded. Reliability of scoring for stereotypic behavior during teaching sessions was calculated by dividing the smaller amount of the measure reported by one scorer (either frequency or duration) by the larger amount reported by the other scorer. These calculations for each teaching session were summed and divided by the number of sessions the stereotypic behavior was scored by two observers. The behaviors recorded (of the children and the teacher) are shown in Table 3 together with the amount of agreement there was between the recordings of the teacher and of the independent observers.

Experimental Design

A parallel treatments design (Gast and Wolery, 1988) was used to compare the effects of intertrial intervals on skill acquisition and stereotypy for three children with autism. A parallel treatment design combines two concurrently implemented multiple probe designs that is

replicated across behaviors and participants. An advantage of using a parallel treatments design is that it allows researchers to compare the effects of two different instructional procedures at approximately the same moment in time for each participant across behaviors.

Results

Effectiveness and Efficiency

Mastery Criterion. Both intertrial interval procedures (pairs taught using the short ITI and pair taught using the long ITI) appeared to be effective in teaching children to touch correct pictures when instructed. As shown in Table 5, nine out of ten pairs of pictures taught using the short intertrial intervals met mastery criterion and eight out of ten pairs of pictures taught using the long intertrial intervals met mastery criterion. As shown in Figure 1, Elliot reached mastery criterion for all pairs taught using the short intertrial interval condition and the long intertrial interval condition. Pair one reached mastery criterion two sessions prior to pair two meeting mastery criterion. All of the following pairs (three, four, five and six) met mastery criterion within the same number of sessions. As shown in Figure 2, Patrick reached mastery criterion for three pairs taught using the short intertrial interval and three pairs taught using the long intertrial interval condition. The pair taught using the long intertrial interval that did not meet mastery criterion, did increase slightly from baseline. The pair that did not meet mastery criterion using the short second intertrial interval remained at baseline levels. As shown in Figure 3, Hailey reached mastery criterion for all pairs taught using the short intertrial interval. Hailey reached mastery criterion for two pairs using the long intertrial interval. The pair that did not meet mastery criterion using the long intertrial interval increased slightly from baseline levels. The short intertrial intervals had a slight advantage in that one more pair of pictures was mastered than in the long intertrial intervals.

Teaching trials. Table 5 shows the number of teaching trials for all participants using both short and long intertrial intervals. Elliot had a total of 360 teaching trials during the short intertrial interval and 400 teaching trials during the long intertrial interval. Patrick had a total of 660 teaching trials in the short intertrial interval and 740 teaching trials during the long intertrial interval. Hailey had a total of 500 teaching trials for the short intertrial interval and 540 teaching trials for the long intertrial interval. Across all participants, when both pairs of pictures reached mastery criterion, there were 80 fewer teaching trials required when using short intertrial intervals (740) than when using long intertrial intervals (820).

Percentage of errors. Table 5 shows the percentage of child errors in both teaching and probe sessions for all participants using both short and long intertrial intervals. Elliot had a slightly lower average percentage of errors during teaching sessions in the short intertrial interval (12.8%) than in the long intertrial interval (14.5%). Similar differences were observed in the average percentage of errors during daily probe sessions. Patrick and Hailey's average percentage of errors during teaching and probe sessions showed slightly fewer errors in the short intertrial interval than the long intertrial interval. During both teaching and probe sessions, it appears that the percentage of errors was approximately the same for both short and long intertrial intervals across all participants.

Average teaching session length. As shown in Table 6, the average teaching session length for the short intertrial intervals across participants was approximately six minutes. The average teaching session length for the long intertrial intervals across participants was approximately nine minutes. These results indicate that using a short intertrial interval would provide a greater amount of teaching time to complete more trials with no loss in speed of learning in a given period of time.

Stereotypic Behavior

As indicated in Table 7 and Figures 4 and 5, there was no apparent systematic relationship between the occurrence of problem behavior and the length of the intertrial intervals. Elliot had higher rates of problem behavior (0.837 instances per minute) in the long intertrial interval condition, Hailey had higher rates of problem behavior (.702 instances per minute) in the short intertrial interval condition, and Patrick had roughly equal rates of problem behavior during both intertrial interval conditions with a rate of 3.689 instances per minute in the short intertrial interval condition and 3.510 instances per minute in the long intertrial interval condition.

Participants' preference for intertrial interval procedures

As specified in Table 8, two out of the three participants, Elliot and Hailey, indicated no preference for intertrial interval condition, while one participant, Patrick, indicated a slight preference for the long intertrial interval condition.

Discussion

The results of this study indicate that short and long intertrial intervals were equally effective in teaching children to point to the correct pictures. These results, however, are not consistent with results found in previous literature. Previous literature on intertrial intervals found higher levels of correct responding and more rapid acquisition and decreases in problem behavior when short intertrial intervals were used in comparison to when long intertrial intervals were used. The results of the present study indicate that correct responding and acquisition rates were roughly the same across short and long intertrial intervals. In the present study, rates of problem behavior were mixed across participants, thus making it difficult to draw a clear conclusion about the effects of intertrial intervals on problem behavior.

The results in the present study indicate that the number of pairs to reach mastery criterion, trials to mastery criterion, and the average percentage of child errors appear to be

similar in the short and long intertrial interval conditions. Thus the results of the present study are not consistent with the earlier research. We did not find more rapid acquisition and higher levels of correct responding with short intertrial intervals as did previous literature, and we did not find higher rates of stereotypic behavior during the long intertrial interval as did Dunlap, Dyer and Koegel (1983).

The reasons for the differences in results between the earlier studies and the present study are not known. There were, however, a number of procedural and other differences between the earlier studies and the present study that could account for the variations in outcomes. First, based on the descriptions of the children that participated in the studies, it appears that the children in the present study had slightly better verbal skills than the children in the earlier studies. Second, in most of the earlier studies, short intertrial intervals were 1 to 4 seconds in length and most of the long intertrial intervals were 5 to 12 seconds long (although in a couple of instances, the long intertrial intervals were 25 or 26 seconds in length). In the present study, short intertrial intervals were 5 to 10 seconds in length and long intertrial intervals were 15 to 20 seconds in length. It is possible that there was not a large enough difference in the present study's intertrial intervals to show differences in effectiveness and efficiency of our procedures. Third, the skills that were taught to the children in the earlier studies were different than the skills taught to the children in the present study. The mixture of tasks used in the previous studies could have potentially affected the rate of acquisition or percentage of correct responding because the tasks were of unequal difficulty. In the present study we used the same type of tasks (i.e. touching picture cards) across all participants and intertrial intervals to further demonstrate experimental control. Finally, the experimental designs used in the present study were different than the experimental designs used in the earlier studies. In the earlier studies, a multiple

baseline design and several reversal designs were used. In these experimental designs, it appears that a group of teaching sessions using one length of intertrial interval trials was used. Then, another group of teaching sessions was presented using the other length of intertrial intervals. In the present study, the short intertrial intervals and the long intertribal intervals were presented within the same teaching session. Thus, the scheduling or mixed presentation of both lengths of intertrial intervals within the same teaching session may have had an effect to reduce the discriminability or saliency of the different lengths of intertrial intervals.

For practical purposes, however, and despite the differences in outcomes between the earlier studies and the present one, it seems reasonably clear that using short intertrial intervals has advantages. First, even though the results of the earlier studies are somewhat different than the results of the present study, none of the data indicate that using long intertrial intervals are associated with faster or better learning. Further, using short intertrial intervals allows a teacher to schedule more frequent teaching trials and, presumably, this would lead to greater amounts of learning during the limited amount of time available for teaching.

While the data presented in this study do not indicate a child preference for specific intertrial intervals, future research might examine teacher preference for specific intertrial intervals. Since both intertrial intervals in this study appeared to be equally effective in teaching receptive labels to the participants, teacher preference could play a large role in the selection of a specific intertrial interval. For example, if teachers may select longer intertrial intervals to allow more time to complete their tasks, such as arranging stimuli and recording responses. This, however, would leave less teaching time and, presumably, produce slower progress in child learning but perhaps greater amounts of teaching because the teacher prefered the format of the teaching.

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Table 1: Skills taught to each child

Child	Procedure	Pairs 1 and 2	Pairs 3 and 4	Pairs 5 and 6	Pairs 7 and 8
Elliot	Short Intertrial Interval	11+1 and 8+9	9+5 and 11+7	5+8 and 3+12	
	Long Intertrial Interval	4+8 and 9+10	11+12 and 9+4	5+11 and 15+4	
Patrick	Short Intertrial Interval	Soap and Shoes	Crib and Jacket	Stove and Puzzle	Desk and Pencil Sharpener
	Long Intertrial Interval	Book and Clock	Baseball Glove and Blocks	Hat and Shovel	Ruler and Iron
Hailey	Short Intertrial Interval	Letter Carrier and Vet	Seamstress and Librarian	Musician and Construction Worker	
	Long Intertrial Interval	Scientist and Receptionist	Custodian and Business Person	Server and Baker	

Table 2: Aberrant Repetitive Behavior Definitions and Measurements

Child	Behavior	Behavioral Definition	Measurement
Elliot	Scripting	Any instance in which Elliot vocalizes and is not oriented toward researcher and content is not relevant to ongoing teaching. The end of a vocalization is when there are no vocalizations for 2 seconds.	Frequency
Patrick	Spitting	Any instance, in which Patrick purses his lips, blows air out of his mouth with a clear audible sound and then returns his lips to their original positioning.	Frequency
Hailey	"Finger Puppets"	Any instance in which Hailey "walks" her fingers across the table or vocalizes and simultaneously holds fingers as if they were puppets or wiggles her fingers in front of her face. The end of behavior will be when there is an absence of any of these finger behaviors for 2 seconds.	Frequency and Duration

Table 3: Interobserver agreement for child and teacher behavior

Child Behavior		Teacher Behavior	
Correct Response	99.5%	Position of Target Picture	99%
Prompted Response	99.6%	Teacher said “Look” Prior to Instruction	99%
		Teacher Asks for Target Picture	99.9%
		Teacher Delivery of Prompt	99.6%
		Teacher Provided Reinforcement	99.6%
		Teacher Provided Physical Touch	99.6%
		Short Intertrial Interval	97%
		Long Intertrial Interval	97%

Table 4: Interobserver agreement for child problem behavior

	Problem Behavior	
Child	Frequency	Duration
Elliot	93% (86% - 100%)	
Patrick	98% (80% - 100%)	
Hailey	94% (71% - 100%)	97% (89% - 100%)

Table 5: Efficiency Table

		Met Mastery Criterion		# of Teaching Trials			% Child Errors During Teaching		% Child Errors During Daily Probes	
Child	Pairs Taught	Short ITI	Long ITI	Short ITI	Long ITI		Short ITI	Long ITI	Short ITI	Long ITI
Elliot	1 and 2	**Yes**	**Yes**	180	220		13.9%	15.9%	27.8%	27%
	3 and 4	**Yes**	**Yes**	80	80		11.3%	13.8%	21.9%	12.5%
	5 and 6	**Yes**	**Yes**	100	100		12%	12%	12.5%	20%
Total trials to criterion when either or both of the pairs met criterion				360	400	Average Percentage	12.8%	14.5%	22.2%	22.5%
Patrick	1 and 2	**Yes**	No	260	320*		35.4%	59.7%*	23.1%	63.3%*
	3 and 4	**Yes**	**Yes**	120	120		17.5%	17.5%	6.3%	2.1%
	5 and 6	No	**Yes**	200*	140		63.5%*	51.4%	56.2%*	7.1%
	7 and 8	**Yes**	**Yes**	100	160		32%	29.4%	5%	4.7%
Total trials to criterion when either or both of the pairs met criterion				680	740	Average Percentage	40%	44.7%	27.2%	30%
Hailey	1 and 2	**Yes**	No	340	400*		56.2%	50.5%*	44.8%	42.5%*
	3 and 4	**Yes**	**Yes**	80	80		8.8%	6.3%	3.1%	3.1%
	5 and 6	**Yes**	**Yes**	80	60		12.5%	20%	6.3%	0%
Total trials to criterion when either or both of the pairs met criterion				500	540	Average Percentage	41.6%	40.5%	32%	31.9%
Total trials to criterion when both pairs met criterion				740	820	Total Average Percentage	34.2%	36.2%	27.6%	28.9%

Table 6: Total Teaching Time

Child	Total Short ITI	Average Short ITI Teaching Session Length	Total Long ITI	Average Long ITI Teaching Session Length
Elliot	116 minutes, 6 seconds	6 minutes, 27 seconds	185 minutes, 7 seconds	9 minutes, 15 seconds
Patrick	199 minutes, 39 seconds	5 minutes, 53 seconds	356 minutes, 1 second	9 minutes, 37 seconds
Hailey	170 minutes, 53 seconds	6 minutes, 6 seconds	291 minutes, 20 seconds	9 minutes, 47 seconds
Total	486 minutes, 38 seconds		832 minutes, 28 seconds	

Table 7: Sample of Problem Behavior

	Sessions Scored	Rate per Minute		Percentage of Teaching Time	
Child		Short ITI	Long ITI	Short ITI	Long ITI
Elliot	10	0.837	2.571	--	--
Patrick	18	3.689	3.510	--	--
Hailey	14	0.702	0.370	3%	2%

Table 8: Child Preference for Procedures

Child	Short ITI	Long ITI	Control
Elliot	Orange	Yellow	Gray
	20% (1/5)	20% (1/5)	60% (3/5)
Patrick	Orange	Yellow	Gray
	11% (1/9)	56% (5/9)	33% (3/9)
Hailey	Pink	Orange	White
	14% (1/7)	0% (0/7)	86% (6/7)
TOTAL	14% (3/21)	29% (6/21)	57% (12/21)

Table 9: Hailey problem behavior before and after reinforcement change

	Frequency		Duration	
	Short ITI	Long ITI	Short ITI	Long ITI
Token Economy	41	44	1 minute, 28 seconds	2 minutes, 50 seconds
Change in Reinforcement	21	13	43 seconds	18 seconds

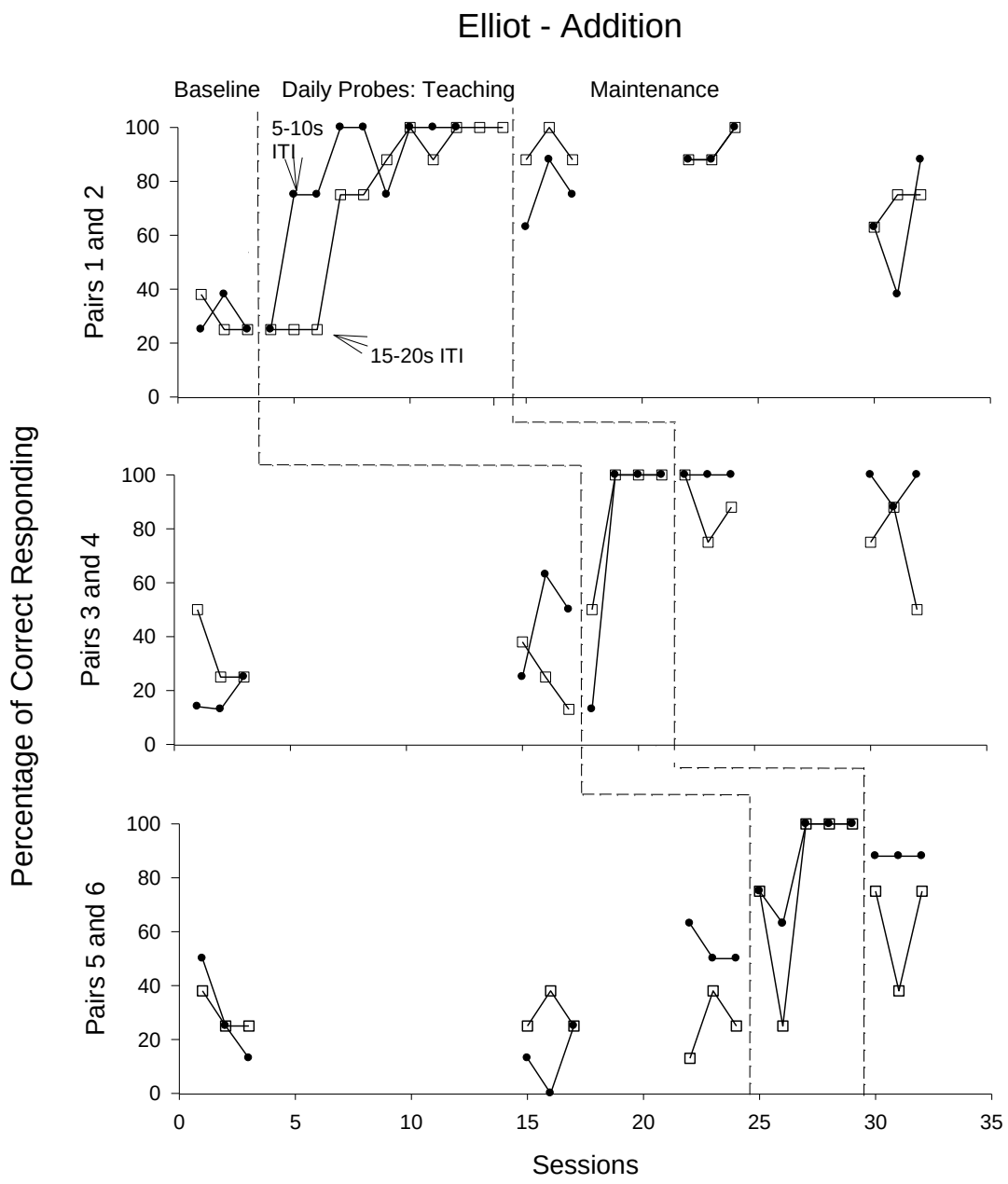

Figure 1. Percentage of probe trials correct during full probes and daily probes across six teaching pairs for Elliot using short intertrial intervals and long intertrial intervals.

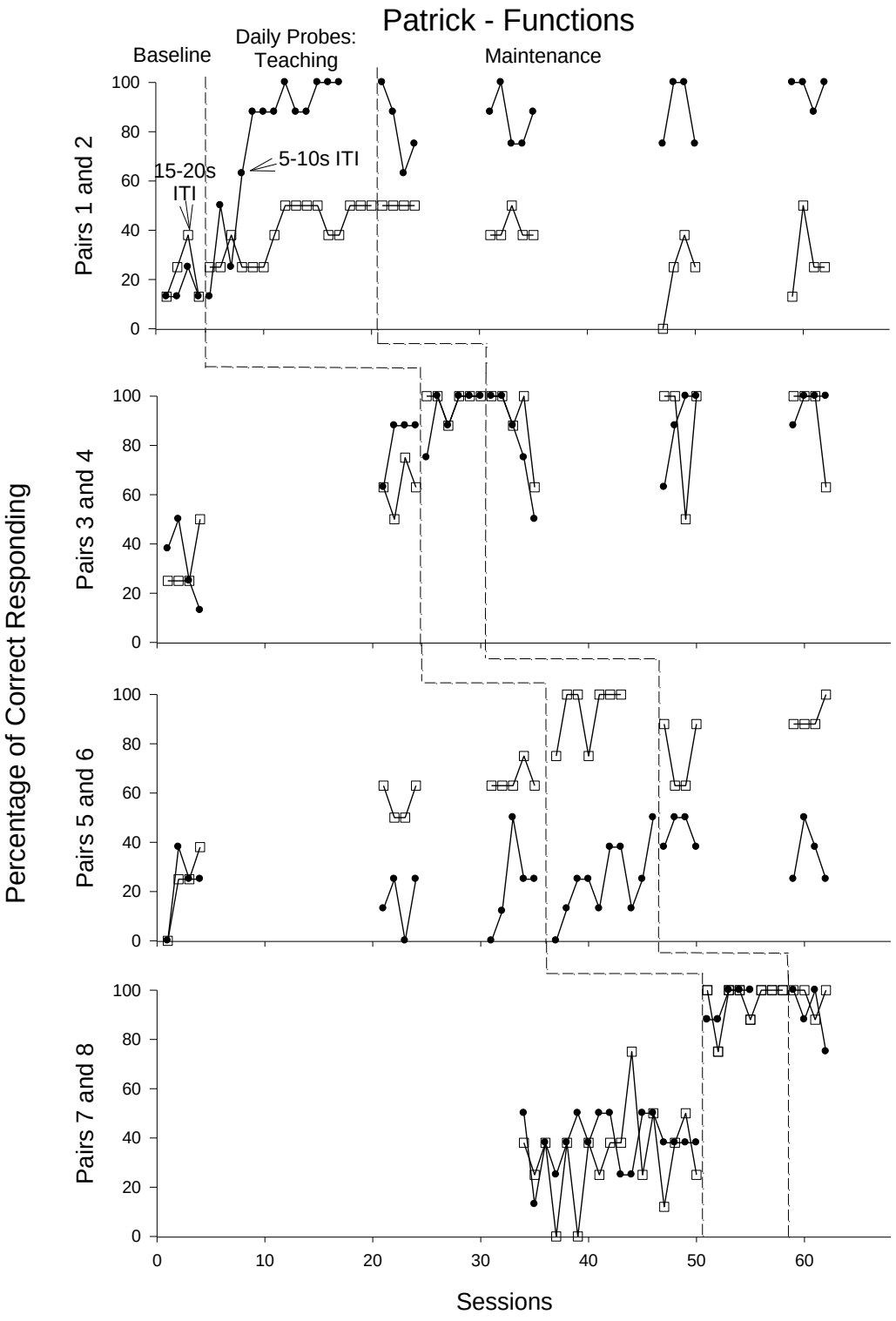

Figure 2. Percentage of probe trials correct during full probes and daily probes across eight teaching pairs for Patrick using short intertrial intervals and long intertrial intervals.

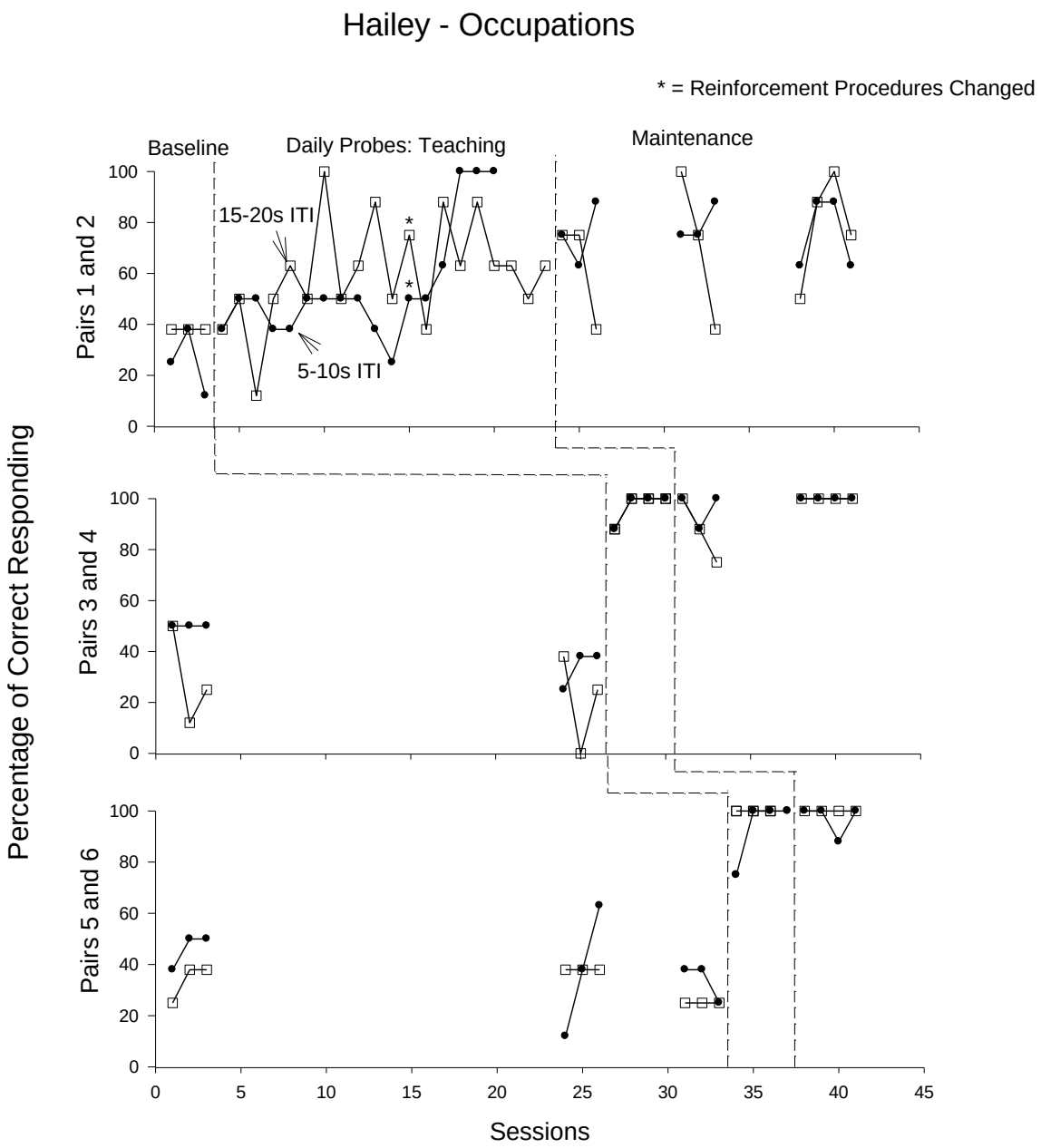

Figure 3. Percentage of probe trials correct during full probes and daily probes across six teaching pairs for Hailey using short intertrial intervals and long intertrial intervals.

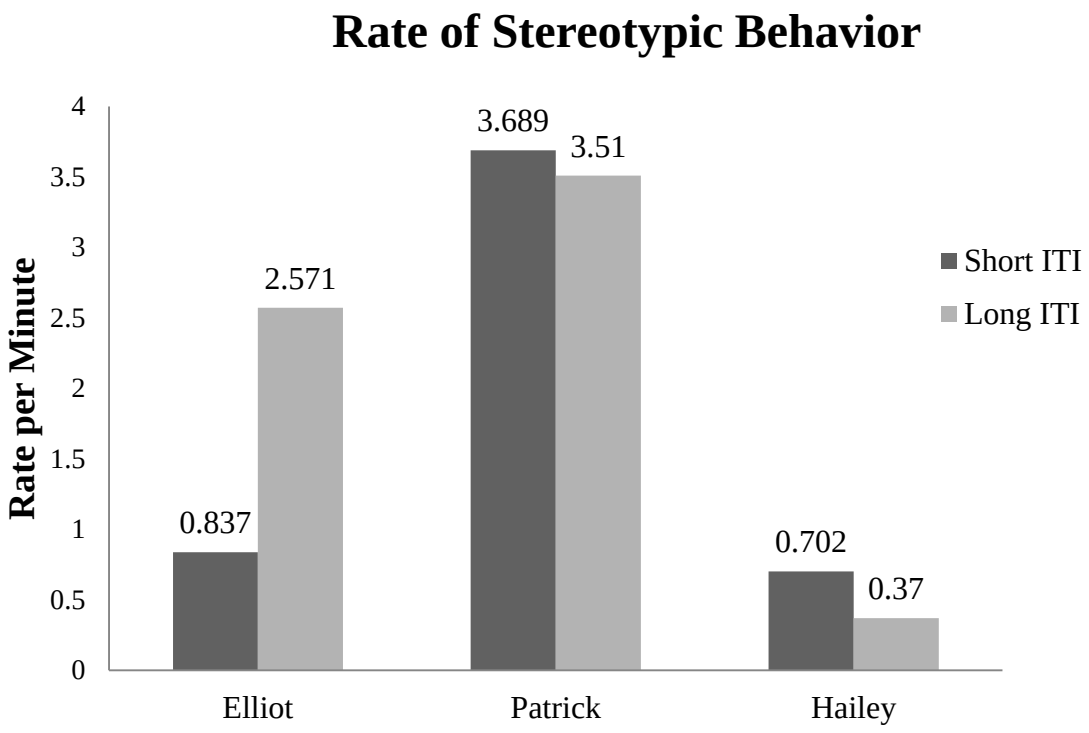

Figure 4. Rate of stereotypic behavior per minute during teaching sessions for all participants.

Appendix A

Trial Data Sheet

Child: _____ Date: _____

5-10s ITI Condition: Session #1 or #2 Session (video) #: _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Target																				
Position																				
Teacher Said "Look"																				
Teacher Asked SD																				
Child Response																				
Teacher Prompt																				
Child Response																				
Reinforcement Provided																				
Physical touch																				
5-10 second ITI Length																				

Target 1: _____ Target 2: _____

Target 1: _____ / _____ + Target 2: _____ / _____ = _____ = _____%

Notes:

- = Incorrect Response
P = Prompted Response
+ = Correct Response

Y= Yes
N= No

Reinforcement
X = 1 Token given
XX = 2 Tokens given

Appendix B

Trial Data Sheet

Child: _____ Date: _____

15-20s ITI Condition: Session #1 or #2 Session (video) #: _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Target																				
Position																				
Teacher Said "Look"																				
Teacher Asked SD																				
Child Response																				
Teacher Prompt																				
Child Response																				
Reinforcement Provided																				
Physical touch																				
5-10 second ITI Length																				

Target 3: _____ Target 4: _____

Target 3: _____ / _____ + Target 4: _____ / _____ = _____ = _____%

Notes:

- = Incorrect Response
P = Prompted Response
+ = Correct Response

Y= Yes
N= No

Reinforcement
X = 1 Token given
XX = 2 Tokens given

Appendix C

Primary Secondary Problem Behavior Data Sheet Child: _____

Session Date	Observer Initials	Type of Teaching Session	Frequency of Problem Behavior per Session	Duration of Problem Behavior per Session
		Short ITI Long ITI		
		Short ITI Long ITI		
		Short ITI Long ITI		
		Short ITI Long ITI		
		Short ITI Long ITI		
		Short ITI Long ITI		
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		Short ITI Long ITI		
		Short ITI Long ITI		

Elliot

Scripting: Any instance in which Elliot vocalizes and is not oriented toward researcher and content is not relevant to ongoing teaching. The end of a vocalization is when there are no vocalizations for 2 seconds. **Frequency**

Patrick

Spitting: Any instance, in which Patrick purses his lips, blows air out of his mouth with a clear audible sound and then returns his lips to their original positioning. **Frequency**

Hailey

"Finger Puppets": Any instance in which Hailey "walks" her fingers across the table or vocalizes and simultaneously holds fingers as if they were puppets or wiggles her fingers in front of her face. The end of behavior will be when there is an absence of any of these finger behaviors for 2 seconds. **Frequency and Duration.**