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## A COMPARISON OF DISCRETE TRIAL TEACHING IMPLEMENTED IN A ONE-TO-ONE INSTRUCTIONAL FORMAT AND IN A GROUP INSTRUCTIONAL FORMAT

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Discrete trial teaching (DTT) is a systematic form of intervention commonly implemented with children and adolescents diagnosed with autism spectrum disorder. Experimenters and clinicians have implemented DTT in both one-to-one instructional formats and group instructional formats to teach a wide variety of skills to children and adolescents diagnosed with autism spectrum disorder. The purpose of this study was to compare DTT implemented in a one-to-one instructional format with DTT implemented in a group instructional format in order to determine which format was more effective, efficient, resulted in higher observational learning, and resulted in better maintenance when teaching a variety of expressive skills. The experimenters utilized a parallel treatment design, and the results indicated that both instructional formats were equally effective, there were mixed results in terms of maintenance and efficiency, and group instruction resulted in observational learning. Copyright © 2012 John Wiley & Sons, Ltd.

Discrete trial teaching (DTT) is a systematic form of instruction commonly implemented with children and adolescents diagnosed with autism spectrum disorder (ASD). DTT consists of three main components: (i) an instruction from the teacher; (ii) a response by the learner; and (iii) a consequence (e.g., positive reinforcement or corrective feedback) provided by the teacher following the learner's response. Experimenters have implemented DTT to teach expressive labeling (e.g., Akmanoglu-Uludag & Batu, 2005), receptive labeling (e.g., Leaf, Sherman, & Sheldon, 2010), self-help skills (e.g., Sewell, Collins, Hemmeter, & Schuster, 1998), and conversational skills (e.g., Charlop & Walsh, 1986; Matson, Sevin, Fridley, & Love, 1990) to children with autism. DTT has been utilized to teach skills to children who are more impacted (e.g., lower cognitive capabilities, language capabilities, and social behaviors) (e.g., Lovaas, 1987) as well as to

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'higher' functioning individuals with ASD (e.g., Leaf, Taubman, McEachin, Leaf, & Tsuji, 2011).

Discrete trial teaching is commonly implemented in a one-to-one instructional format (Akmanoglu-Uludag & Batu, 2005; Leaf & McEachin, 1999; Lovaas, 1987). One-to-one teaching consists of the teacher and student working solely together. One-to-one teaching can minimize distractions, maximize the amount of teaching trials delivered to the learner, and has been found to be effective in teaching a wide variety of skills. DTT can also be implemented in a group instructional format, which usually consists of multiple students with ASD sitting in-front of a single teacher. The teacher can either implement teaching trials chorally (e.g., 'Everyone clap your hands'), with the expectation that all students respond simultaneously, or implement teaching trials sequentially (e.g., 'Billy clap your hands'), where one student responds at a time. Group instructional learning has several advantages for both teachers and students. For one, group instruction may be more efficient for teachers, as they can work with multiple children simultaneously. Second, group instruction more closely represents instruction that can be found in general education classrooms. Third, group instruction may lead to students observationally learning correct responses from their peers.

Researchers have recently shown DTT to be effective when implemented in group instruction for teaching individuals with ASD a wide variety of skills. For example, Taubman et al. (2001) evaluated DTT in a group instructional format for eight participants, two of whom were diagnosed with ASD. Using a multiple baseline design across behaviors, the experimenters evaluated the effects of group instruction for teaching choral responding during songs (e.g., all of the participants responding simultaneously), pre-math skills, and expressive and receptive language skills. Results of the study indicated that all three methods (e.g., choral instructions, overlapping instructions, and sequential instructions) of group instruction were effective in teaching participants the various targeted skills. Thus, results indicated that DTT implemented in a group instructional format could be effective in teaching new behaviors to children with autism.

In a more recent study, Ledford, Gast, Luscre, and Ayres (2008) examined the effects of DTT implemented in a group instructional format to teach six young children with ASD (ages 5–8 years) to learn sight words/phrases through observational methods. The experimenters implemented DTT using a constant time delay prompting procedure to teach participants to observationally learn sight words or phrases. Four out of six participants learned 100% of the information taught to their peers; the other two participants learned 67% of the information taught to their peers.

Leaf and colleagues (2011) evaluated the effectiveness of DTT using a no-no-prompt error correction procedure for teaching four higher functioning children diagnosed with ASD and one typically developing child how to expressively label pictures of people displaying emotions. Results indicated that the participants were able to learn the

emotions directly taught to them and learned additional skills through observational learning. Thus, the experimenters showed that DTT implemented in a group instructional format not only resulted in learning of skills directly taught to the participant but also yielded the additional benefit of observational learning.

Experimenters have compared one-to-one instructional formats with group instructional formats for students with disabilities other than autism (e.g., Favell, Favell, & McGimsey, 1978; Storm & Willis, 1978). These experimenters showed that both instructional formats were effective in teaching participants new skills. Yet, few studies have compared the relative effectiveness and efficiency of DTT when implemented in various instructional formats for children with autism (e.g., Kamps, Walker, Locke, Delquadri, & Hall, 1990). Kamps and colleagues compared DTT implemented in a one-to-one instructional format with DTT implemented in a group instructional format to teach sight words to three children diagnosed with autism. The three participants in this study ranged in age from 8 to 11 years with IQ scores ranging from 39 to 50. The experimenters evaluated the effectiveness of teaching in a one-to-one format versus a group format with instructors of various experience and skill level (i.e., classroom teacher, paraprofessionals, and peers). Results of the study were variable but indicated that the one-to-one instructional format was effective when implemented by an adult and that the group instructional format was effective when implemented by a more experienced teacher.

The implementation of DTT in both a one-to-one instructional format and a group instructional format may be needed to teach higher functioning children with autism a wide variety of skills. Furthermore, clinicians and researchers have shown that DTT implemented in both a one-to-one instructional format and a group instructional format may have tremendous benefits for higher functioning children diagnosed with autism, including becoming indistinguishable from their peers (e.g., Leaf et al., 2011). However, to date, there has been no research that has compared DTT implemented in a one-to-one instructional format with DTT implemented in a group instructional format for children with autism who are considered higher functioning. Therefore, the purpose of this study was to extend the current literature by comparing the relative effectiveness, efficiency, observational learning, maintenance, and participant responding during DTT implemented in both one-to-one and group instructional formats for children diagnosed with ASD.

## **METHOD**

### **Participants**

The participants in this study had the following characteristics: (i) a diagnosis of autistic disorder by an independent clinician, based upon DSM IV-R criteria, using

standardized diagnostic assessments and evaluations; (ii) a full scale IQ score of 85 or above; (iii) were between the ages of 3 and 8 years; and (iv) their current ABA interventions included DTT implemented in both one-to-one and group instructional formats. Six children met this criterion, and the researchers randomly divided the six participants into two groups (i.e., Group 1 and Group 2); both of the groups received intervention.

### *Group 1*

Group 1 consisted of three children, all who would be considered higher functioning. Jordan was a 4-year-old boy diagnosed with autistic disorder. Jordan had a Wechsler Preschool and Primary Scale of Intelligence Third Edition (WPPSI-III) full scale IQ (FSIQ) score of 117, a Vineland Adaptive Behavioral Scales Second Edition (VABS-II) adaptive behavior score of 83, and a Gilliam Autism Rating Scale (GARS-II) autism quotient of 72 (Possibility of Autistic Disorder). At the beginning of the study, Jordan was receiving a mean of 27 h of behavioral treatment per week, and he was placed in a general education preschool classroom with supports.

Kenny was a 4-year-old boy diagnosed with autistic disorder. Kenny had a WPPSI-III FSIQ score of 128, a VABS-II adaptive behavior score of 94, and a GARS-II autism quotient of 98 (probability of autism very likely). At the beginning of the study, Kenny was receiving a mean of 20 h of behavioral treatment per week, and he was placed in a special education preschool classroom with supports.

Tammy was a 4-year-old girl diagnosed with autistic disorder. Tammy had a WPPSI-III FSIQ score of 126 and a VABS-II adaptive behavior score of 78. At the beginning of the study, Tammy was receiving a mean of 27 h of behavioral treatment per week, and she was placed in a general education preschool classroom with supports.

### *Group 2*

Group 2 consisted of three children, all whom would be considered higher functioning. Jeff was a 4-year-old boy diagnosed with autistic disorder. Jeff had a WPPSI-III FSIQ score of 99, a VABS-II adaptive behavior score of 88, and a GARS-II autism quotient of 89 (probability of autism very likely). At the beginning of the study, Jeff was receiving a mean of 5 h of behavioral treatment per week, and he was placed in a general education preschool classroom without supports.

Josh was a 4-year-old boy diagnosed with autistic disorder. Josh had a WPPSI-III FSIQ score of 86, a VABS-II adaptive behavior score of 81, and a GARS-II autism quotient of 98 (probability of autism very likely). At the beginning of the study, Josh

was receiving a mean of 5 h of behavioral treatment per week, and he was placed in a special education classroom without supports.

Emily was a 4-year-old girl diagnosed with autistic disorder. Emily had a Stanford Binet FSIQ score of 98 and a Childhood Autism Rating Scale autism score of 37. At the beginning of the study, Emily was receiving a mean of 29 h of behavioral treatment per week; Emily was not yet enrolled in school at the time of the study.

## **Setting**

Research sessions were conducted at a private agency that provides behavioral intervention to children and adolescents diagnosed with ASD. Research sessions were conducted twice per week with a research session lasting approximately 45 min across all of the participants. Research sessions were conducted in a small research room that measured 2.7 m by 2.8 m and contained chairs and cabinets to hold reinforcers and other instructional materials. Researchers conducted the research sessions while the participants were participating in a large social skills group. The researcher would pull the participants out from the social skills group and bring them to the research room to run all aspects of the research session (e.g., probe trials, one-to-one teaching condition, and group instructional condition).

## **Skills Taught**

The researchers taught each participant 12 different targeted skills; half of the skills were randomly assigned to the one-to-one condition and half were randomly assigned to the group instructional condition. The researchers taught targeted skills in stimulus pairs. Thus, the researchers taught participants to discriminate between two targeted skills in the one-to-one condition and to discriminate between two targeted skills in the group instructional condition at any given time. No two participants within a group had the same targeted skills. For example, none of Jordan's skills were directly taught to Kenny or Tammy, either during one-to-one or group teaching. The researchers selected each of the participants' skills by talking to behavioral supervisor(s) for each of the participants; skills selected were ones that the supervisors indicated were not in the participants' repertoire and would not be clinically intervened upon during the duration of the study. Table 1 provides information on the skills that we taught each participant across the two teaching conditions.

## **General Procedures**

Research sessions were conducted twice per week. For a single participant, the one-to-one condition ranged from 1 min and 40 s to 4 min and 30 s. The group condition

Table 1. Skills taught.

Group	Participant	Format	Pair 1	Pair 2	Pair 3
Group 1	Jordan	One-to-one	Expressive label: flounder and partida	Job function: chemist and bell hop	Job function: novelist and architect
		Group	Expressive label: King John and Maid Marian	Job function: podiatrist and esthetician	Job function: politician and referee
Group 1	Kenny	One-to-one	Expressive label: prosciutto and salmon	Expressive label: crepe and tiramisu	Expressive label: Robin Hood and Merlin
		Group	Expressive label: pomegranate and salami	Expressive label: Fondue and Danish	Expressive label: bashful and Merryweather
Group 1	Tammy	One-to-one	Materials need for play: house and princess	Functions: 3 Hole puncher and cleaver	Function: food processor and ladle
		Group	Materials need for play: doctor and teacher	Functions: ottoman and ruler	Function: duvet and cork screw
Group 2	Jeff	One-to-one	Social inferences: superheroes and dolls	Functions: whisk and ladle	Expressive label: pomegranate and beef jerky
		Group	Social inferences: Star Wars and fast food restaurants	Function: cleaver and ruler	Expressive label: pimento and Danish
Group 2	Josh	One-to-one	Function: 3 hole puncher and crock pot	Expressive label: guava and salmon	Expressive label: crème brule and flan
		Group	Function: refrigerator and toaster	Expressive label: pork chop and crepe	Expressive label: fondue and éclair
Group 2	Emily	One-to-one	Job function: life guard and athlete	Job function: cashier and custodian	Function: food processor and cork screw
		Group	Job function: librarian & gardner	Job function: cartoonist & mechanic	Function: tenderizer & paperclip

ranged from 5 min and 30 s to 13 min and 30 s. Thus, a research session for all participants (all one-to-one sessions and both group sessions) lasted approximately 30 to 45 min.

The research was broken into two conditions: the baseline/maintenance condition (i.e., full probes) and the intervention condition (i.e., daily probes, one-to-one condition, and group instructional condition). There were two types of trials (i.e., probe and teaching trials) implemented throughout the study. The researchers scored a trial, for both probe and teaching trials, as anytime a discriminative stimulus was provided to the participant. The first type of trials that were implemented in this study was probe trials, which were implemented during full probe and daily probe sessions. A probe trial began with the researcher providing a verbal discriminative stimulus (e.g., 'What is this?', or 'What is a stapler for?') and, when applicable, holding up a picture displaying the targeted item. The participant then had approximately 5 s to respond to the discriminative stimulus. If the participant responded correctly or incorrectly, the researcher said 'thank you' and moved to the next probe trial. If the participant did not respond within the 5 s, the researcher said 'ok' and moved to the next probe trial.

The second type of trials implemented in this study were teaching trials, which were implemented during the one-to-one condition and group instructional condition. A teaching trial consisted of the researcher providing a verbal discriminative stimulus (e.g., 'What is this?', or 'What is her name?') and, if applicable, holding up a picture displaying the targeted item. The participant then had 5 s to respond to the discriminative stimulus. If the participant responded correctly, he or she received praise and two tokens and then the researcher implemented the next predetermined trial. If the participant responded incorrectly or did not respond within 5 s, the researcher provided corrective feedback (e.g., 'Nope, that's not it' or 'You need to answer') followed by a remedial trial in which the researcher provided the same discriminative stimulus, with a verbal model of the correct response. If the participant responded correctly during the remedial trial, the participant received praise and one token, and the researchers implemented the next predetermined trial. If the participant responded incorrectly or did not respond within 5 s on the remedial trial, the researchers provided corrective feedback and implemented the next predetermined teaching trial. Because the researcher provided a separate discriminative stimulus during remedial trials, remedial trials were scored as separate trials.

If a participant was absent on any day, the experimenter replaced him or her with another child from the agency for the group instructional condition only. Because participants could learn skills at different rates, it was possible for one participant to master all of his or her targets in the group instructional condition, whereas the other one or two participants had not mastered his or her targets. For example, Jeff could have mastered his two targets in the group instructional condition, whereas Josh and Emily had yet to master their targets. When this occurred, the participant still took part of the group

instructional condition. However, the participant received only easy questions (e.g., ‘What is your name?’ ‘What is the color of your shirt?’ ‘How old are you?’), rather than normal targeted skills. This continued until the participant was ready to begin teaching on his or her next set of targeted skills or until all of the participants mastered all of their skills.

### **Full Probe Sessions**

Full probe sessions were conducted prior to the teaching of any new stimulus pairs and once a participant reached mastery criterion for the two targets taught with the one-to-one condition and the two targets taught with the group instructional condition. Thus, full probe sessions were used to assess baseline and maintenance of skills taught with both teaching conditions. Each of the 12 targeted skills received four probe trials, for a total of 48 probe trials (described earlier). The order of presentation of each targeted skill was randomly determined ahead of time. The researcher provided reinforcement to the participant after every fourth to sixth trial contingent upon participant compliance and absence of any aberrant behavior (e.g., crying, looking away, and engaging in stereotypy). During full probes, only a single participant, the researcher, and the occasional reliability observer were present in the room.

### **Daily Probe Sessions**

Daily probes were conducted prior to the one-to-one teaching condition and the group instructional condition during research sessions; within the intervention condition the purpose of daily probe sessions was to determine if the participants were acquiring the skills targeted in the two teaching conditions. Mastery criterion was set as a participant achieving 100% correct responding (for both targeted skills) on probe trials for three consecutive sessions. Once a participant met mastery criterion for a stimulus pair, teaching on that pair stopped and the researcher no longer probed those skills. The researcher continued to implement teaching sessions and probe trials for the stimulus pair that did not reach mastery criterion until at least seven more sessions were implemented or the second stimulus pair also reached master criterion. During daily probes, only a single participant, the researcher, and the occasional reliability observer were present in the room. Daily probe sessions were similar to full probe sessions except that the researcher only implemented probe trials for the four targeted skills currently being intervened upon. There were a total of 16 probe trials during daily probes (four trials per target).

### **Teaching Sessions**

After the daily probe sessions, the researchers implemented either the one-to-one condition or the group instructional condition. The order of the two conditions was randomly determined prior to the research session.



### *One-to-One Condition*

During the one-to-one condition, only the participant, the researcher, and the occasional reliability observer were present in the room. The one-to-one condition consisted of 10 to 20 teaching trials (described earlier) per participant, depending on the participants' accuracy of responding (i.e., if remedial trials were needed because of incorrect responding). The two targeted skills were interspersed, and the order was randomly predetermined. The duration of one-to-one sessions was not fixed but varied in length dependent upon the participant's responding.

### *Group Instructional Condition*

During the group instructional condition, the three participants of a group, the researcher, and the occasional reliability observer were present in the room. The group instructional condition consisted of 10 to 20 teaching trials per participant, depending on the participants' accuracy of responding (i.e., if remedial trials were needed because of incorrect responding). Because a group consisted of three participants, there were a total of 30 to 60 teaching trials per group teaching session, dependent upon the participants' responding. The order of trials across the three participants and the six targeted skills was interspersed and randomly determined ahead of time. The duration of group instructional sessions was not fixed but varied in length dependent upon the participant's responding.

### *Reinforcement*

The researchers implemented a token economy (Ayllon & Azrin, 1965) throughout the intervention condition. The participants received tokens (in the form of tickets) for answering questions correctly in the one-to-one and group instructional conditions. The total amount of possible tickets that participants could earn across both conditions was 40 tickets (i.e., 20 tokens per teaching condition). At the end of both conditions, participants could exchange tickets for tangible items. If the participants received 40 tickets (the maximum amount of tickets), they could exchange their tickets for 5 min of play in a room with over 500 different toys. If the participants received 32–39 tickets, they could exchange their tickets for 3 min of play in a room with over 500 different toys. If the participants receive 28–31 tickets, they could exchange their tickets for 1 min of play in a room with over 500 different toys. If the participants received less than 28 tickets, they did not receive any reinforcement.

## **Observational Probes**

To determine if participants were able to observationally learn targets taught to the other two members of their group, the researchers implemented observational probe

sessions prior to intervention, once a participant reached mastery criterion on all of his or her targeted skills and once all participants within a group reached mastery criterion on all targeted skills. Therefore, the final participant within a group to reach mastery criterion on all targeted skills only received observational probes prior to intervention and once all participants within a group reached mastery criterion on all targeted skills. During observational probe sessions, probe trials were conducted for each of the skills targeted within both the group instructional condition and the one-to-one instructional condition (control targets) for each of the participants' peers. There were a total of 48 observational probe trials per session, two for each target. Observational probe trials were identical to probe trials conducted throughout the study. All observational probe trials were implemented in a one-to-one instructional format, and only the researcher, the participant, and the occasional reliability observer were present in the research room.

## **Dependent Variables and Response Definitions**

The researchers evaluated multiple measures throughout the study. The primary measure was the number of stimulus pairs for which each participant reached mastery criterion (i.e., 100% correct responding on three consecutive probe sessions) for each of the two teaching conditions.

Second, the researchers measured the maintenance of each of the stimulus pairs taught for the two teaching conditions during the baseline/maintenance condition. Third, the researchers implemented a pre–post test to measure observational learning for each of the participants. Fourth, the researchers measured participants' responses during teaching sessions for both conditions. A teaching trial was defined as any time the researcher gave a discriminative stimulus; therefore, remedial teaching trials were considered a separate teaching trial. During teaching trials, researchers recorded whether the participant's response was correct, incorrect, or prompted or whether the participant did not respond within 5 s of the instruction. Fifth, as indicators of efficiency, the experimenters measured the total amount of time, total number of teaching trials, and total number of sessions it took participants to reach mastery criterion with the two teaching conditions.

Finally, the researchers measured correct teacher behaviors for the two teaching conditions. Correct instructor behaviors during both teaching conditions included the researcher (i) delivering a correct instruction; (ii) allowing the participant 5 s to respond; (iii) providing praise following a correct response; (iv) providing the participant with two tokens for a correct response; (v) providing corrective feedback for an incorrect response; and (vi) when the participant responded incorrectly, presenting a remedial trial that included (1) re-presenting the same instruction, (2) providing a verbal prompt with a 0 s delay, (3) providing praise and one token following a correct prompted response, and (4) providing corrective feedback for an incorrect prompted response.

## **Interobserver Agreement**

The researcher recorded participant behaviors during every probe and teaching session, and an independent observer (first or second author) also recorded participant behaviors during 36.9% (range, 33–41.6% across participants) of the full probe sessions, 35.4% (range, 29.4–44.4% across participants) of the daily probe sessions, 46.8% (range, 33.3–75% across participants) of the observational probe sessions, 39% (range, 31.3–50% across participants) of the one-to-one teaching sessions, and 33.3% of the group teaching sessions.

Interobserver agreement was calculated by totaling the number of agreements (i.e., trials for which both observers scored the same participant behavior) for each type of participant response divided by the number of agreements plus disagreements (i.e., trials in which the two observers scored a different participant behavior) and converting this ratio to a percentage. Percentage agreement across all participant responses was 99.8% (range, 97.9–100% per session) for full probe sessions, 99.1% (range, 81.3–100%) for daily probe sessions, 98.2% (range, 93.8–100%) for observational probe sessions, 100% for one-to-one teaching sessions, and 99.7% (range, 97.9–100%) for group teaching sessions summed across all six participants.

## **Treatment Fidelity**

To assess treatment fidelity, an independent observer (first or second author) recorded the researcher's implementation of correct instructor behaviors (described earlier) during 37.6% of teaching sessions in the one-to-one condition and 34.3% of teaching sessions in the group instructional condition. The independent observer reported that the researcher implemented correct instructor behaviors on 99.8% (range, 98.5–100%, across participants) of the one-to-one teaching trials and 99.8% (range, 98.6–100%, across participants) of the group teaching trials.

## **Experimental Design**

The experimenters used a parallel treatment design (Gast & Wolery, 1988) nested in a multiple probe design to evaluate the effectiveness of the two teaching conditions on each participant's acquisition of targeted skills. The researchers selected the parallel treatment design because it compares two or more independent variables on one or more dependent variables. Experimental control is established when one of the dependent variables that is assigned to a particular independent variable increases more rapidly than the other. However, because DTT has been found to be effective both when implemented in a one-to-one instructional format and in a group instructional format, the researchers combined the parallel treatment design with a multiple probe design to

show that the participants would only start responding correctly when teaching had begun across multiple skill targets. Thus, the multiple probe design also controls for changes over time.

## RESULTS

### **Skill Acquisition, Mastery Criterion, and Maintenance**

Across the six participants, the experimenter taught 18 stimulus pairs (36 targets) with the one-to-one condition and 18 stimulus pairs (36 targets) with the group instructional condition. Across all participants, mastery criterion was reached on 17 stimulus pairs in the one-to-one teaching condition, and mastery criterion was reached on 17 stimulus pairs in the group teaching condition (Figures 1–6).

Jordan reached mastery criterion for all stimulus pairs taught in both the one-to-one condition and the group instructional condition (Figure 1). During the assessment of maintenance, Jordan's mean correct responding on the stimulus pairs was 99.3% (range, 87.5–100% per session) for skills taught in the one-to-one condition and was 81.9% (range, 0–100% per session) for skills taught in the group instructional condition.

Kenny reached mastery criterion for all stimulus pairs taught in the one-to-one condition and the group instructional condition (Figure 2). During the assessment of maintenance, Kenny's mean correct responding on the stimulus pairs was 90.9% (range, 37.5–100% per session) for skills taught in the one-to-one condition and was 90.9% (range, 50–100% per session) for skills taught in the group instructional condition.

Tammy reached mastery criterion for all stimulus pairs taught in the one-to-one condition and the group instructional condition (Figure 3). During the assessment of maintenance, Tammy's mean correct responding on the stimulus pairs was 76.4% (range, 0–100% per session) for skills taught in the one-to-one condition and was 95.9% (range, 87.5–100% per session) for skills taught in the group instructional condition.

Jeff reached mastery criterion for all stimulus pairs taught in the one-to-one condition and the group instructional condition. During the assessment of maintenance, Jeff's mean correct responding on the stimulus pairs was 93.1% (range, 50–100% per session) for skills taught in the one-to-one condition and was 88.8% (range, 37.5–100% per session) for skills taught in the group instructional condition.

Josh reached mastery criterion for two of the three stimulus pairs taught in the one-to-one condition and reached mastery criterion for all stimulus pairs taught in the group instructional condition. During the assessment of maintenance, Josh's mean correct responding on the stimulus pairs was 91.7% (range, 62.5–100% per session) for skills taught in the one-to-one condition and was 90.3% (range, 37.5–100% per session) for skills taught in the group instructional condition.

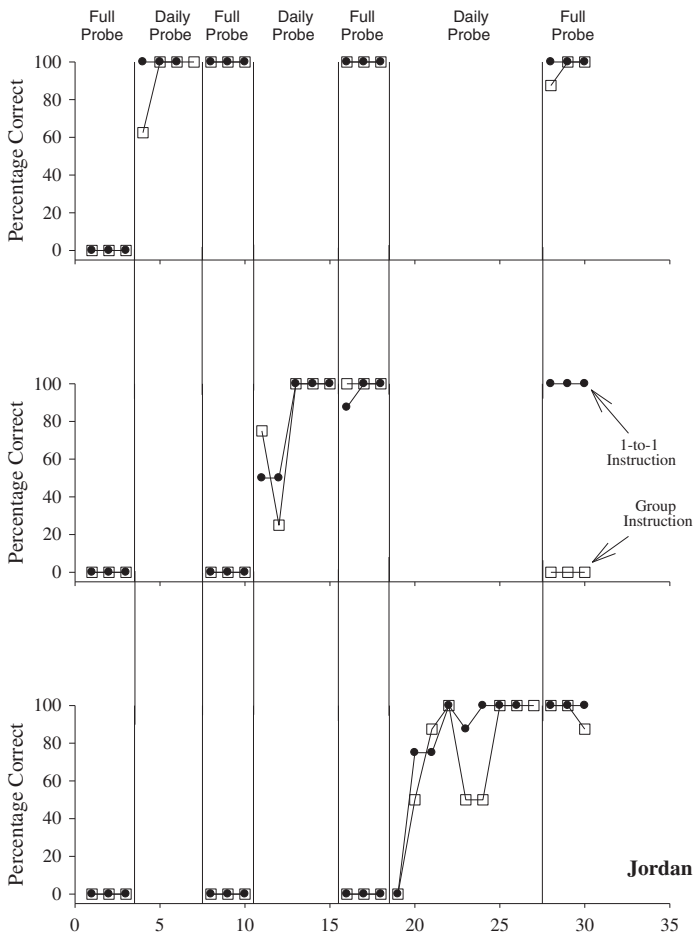


Figure 1. Jordan percentage of trials correct during full and daily probe trials.

Emily reached mastery criterion for all stimulus pairs taught in the one-to-one condition and reached mastery criterion for two of the three stimulus pairs taught in the group instructional condition. During the assessment of maintenance, Emily’s mean correct responding on the stimulus pairs was 81.9% (range 37.5% – 100% per session) for skills taught in the one-to-one condition and was 61.8% (range, 0–100% per session) for skills taught in the group instructional condition.

### Observational Learning

Table 2 displays each participant’s average correct responding prior to any intervention, following mastery of all skills directly taught to the participant, and following mastery of

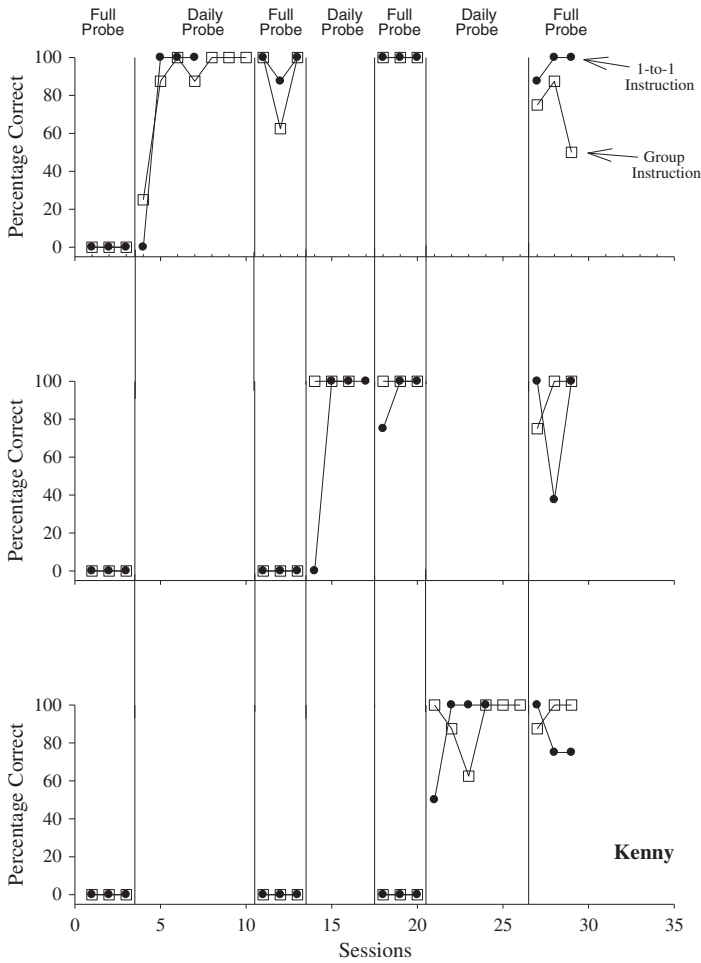


Figure 2. Kenny percentage of trials correct during full and daily probe trials.

skills for all members of the group, on all observational targets across the two teaching conditions. For targets taught in the one-to-one condition, the average correct responding across all participants on observational probes prior to any intervention was 4.2%, following mastery of all skills directly taught to the participant was 5.2%, and following mastery of all skills for an entire group was 6.9%. Thus, across all participants, there was a 2.7% increase in performance following intervention.

For the group instructional condition, the average correct responding across all participants on observational probes prior to any intervention was 4.5%, following mastery of all skills directly taught the participant was 55.9%, and following mastery

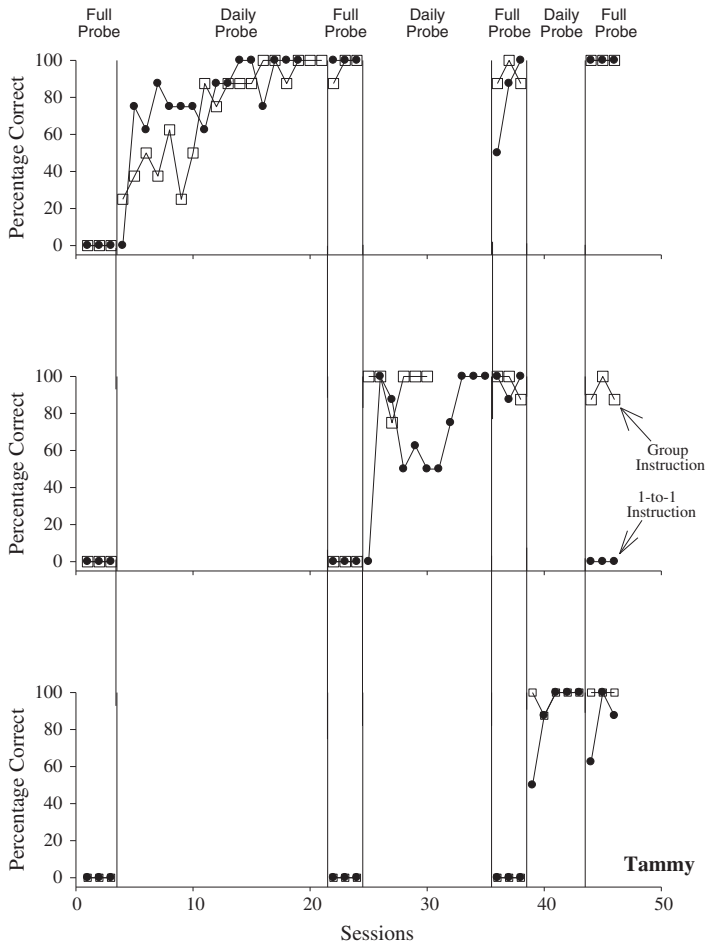


Figure 3. Tammy percentage of trials correct during full and daily probe trials.

of all skills for an entire group was 34.1%. Thus, across all participants, there was a 29.6% increase in performance following intervention.

### Teaching Trials (Number and Percentage of Responses)

Table 3 represents the percentage of correct responses, percentage of incorrect responses/no responses, and percentage of prompted responses for each participant for teaching trials in both the one-to-one condition and the group instructional condition. Across all participants, there were mixed results in the level of correct responding across the two teaching conditions. Across all participants, the average correct responding in

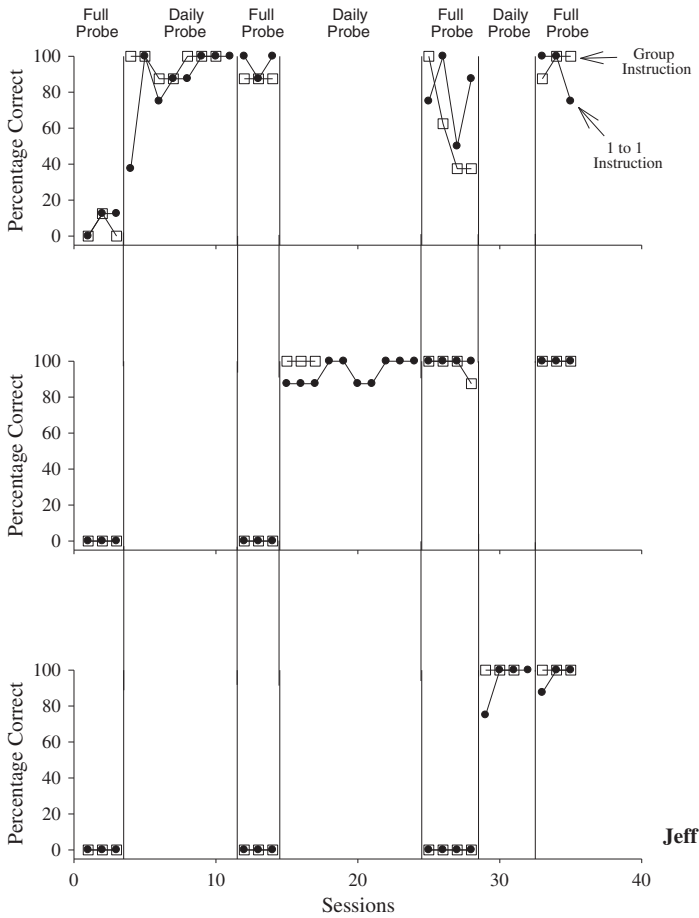


Figure 4. Jeff percentage of trials correct during full and daily probe trials.

the one-to-one condition was 71.3%, and the average correct responding in the group condition was 67.3%.

Jordan's correct responding rate during teaching trials for the one-to-one condition was 82%, 82%, and 80% for the first, second, and third stimulus pairs, respectively. Jordan's correct responding rate during teaching trials for the group instructional condition was 72%, 73%, and 80% for the first, second, and third stimulus pairs, respectively. Kenny's correct responding rate during teaching trials for the one-to-one condition was 74%, 70%, and 70% for the first, second, and third stimulus pairs, respectively. Kenny's correct responding rate during teaching trials for the group instructional condition was 87%, 72%, and 84% for the first, second, and third stimulus pairs, respectively. Tammy's correct responding rate during teaching trials for the one-to-one condition



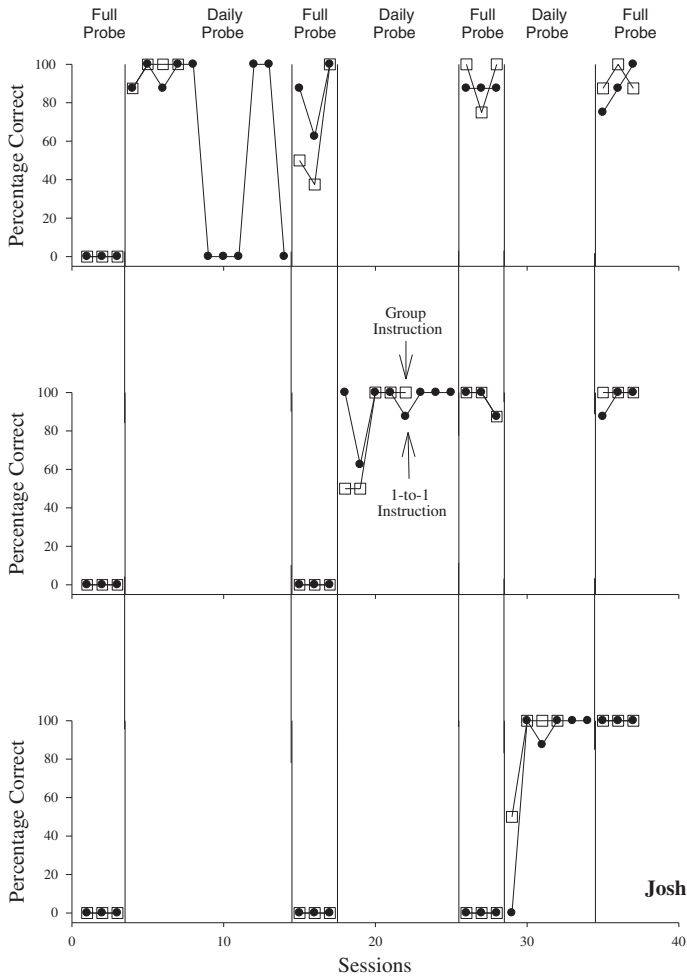


Figure 5. Josh percentage of trials correct during full and daily probe trials.

was 76%, 56%, and 85% for the first, second, and third stimulus pairs, respectively. Tammy's correct responding rate during teaching trials for the group instructional condition was 74%, 90%, and 92% for the first, second, and third stimulus pairs, respectively.

Jeff's correct responding rate during teaching trials for the one-to-one condition was 74%, 87%, and 82% for the first, second, and third stimulus pairs, respectively. Jeff's correct responding rate during teaching trials for the group instructional condition was 80%, 67%, and 88% for the first, second, and third stimulus pairs, respectively. Josh's correct responding rate during teaching trials for the one-to-one condition was 76%, 50%, and 34.8% for the first, second, and third stimulus pairs, respectively. Josh's

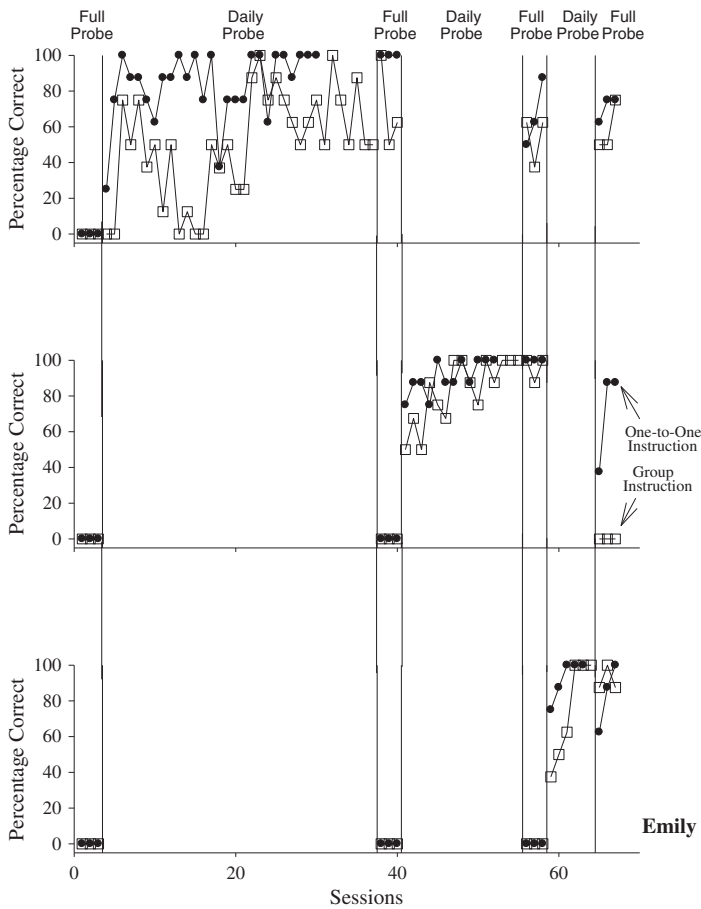


Figure 6. Emily percentage of trials correct during full and daily probe trials.

correct responding rate during teaching trials for the group instructional condition was 74%, 24%, and 40% for the first, second, and third stimulus pairs, respectively. Emily's correct responding rate during teaching trials for the group condition was 66%, 88.9%, and 75% for the first, second, and third stimulus pairs, respectively. Emily's correct responding rate during teaching trials for the group instructional condition was 49.5%, 85%, and 61.7% for the first, second, and third stimulus pairs, respectively.

## Efficiency

Table 4 represents the total amount of sessions, total amount of trials, total amount of instructional time for the one-to-one instructional condition, total amount of time

Table 2. Observational learning data.

Participant	One to one prior, %	One to one following intervention (only skills that have been targeted), %	One to one following all participants in a group reaching mastery, %	Group instruction prior, %	Group instruction following intervention (only skills that have been targeted), %	Group instruction all participants in a group reaching mastery, %
Jordan	0	10	4	15	48	69
Kenny	8	0	0	2	37.5	19
Tammy	8	—	17	0	—	8
Group 1	5.5	5	6.9	5.5	42.5	31.9
Jeff	0	17	6.25	4	100	66.7
Josh	0	0	0	0	57	37.5
Emily	8	—	14.6	6	—	4.1
Group 2	2.7	5.5	6.9	3.5	70.8	36.1
Total across all participants	4.2	5.2	6.9	4.5	55.9	34.1

Table 3. Analysis of teaching trials for both conditions.

Participant	Percentage of trials correct (one to one)	Percentage of trials correct (group)	Percentage of trials incorrect (one to one)	Percentage of trials incorrect (group)	Percentage of trials prompted (one to one)	Percentage of trials prompted (group)
Jordan	80.8	75.8	9.6	12.1	9.6	12.1
Kenny	71.2	82.8	14.4	8.6	14.4	8.6
Tammy	70.2	79.6	14.9	10.2	14.9	10.2
Group 1	73.2	79.2	18.4	10.4	18.4	10.4
Jeff	81	78	9.5	11	9.5	11
Josh	56.6	41.6	21.7	29.2	21.7	29.2
Emily	73.3	59.3	13.6	20.2	13.6	20.2
Group 2	70	58.6	15	20.7	15	20.7
Across both groups	71.3	67.3	14.3	16.4	14.3	16.4

Table 4. Analysis of efficiency for both conditions.

Participant	Total # of sessions (one to one)	Total number of sessions (group)	Total number of trials (one to one)	Total number of trials (group)	Total amount of time with teaching targets (one to one)	Total amount of group time and groups while participants are learning observationally	Amount of group time working on targets directly
Jordan	16	18	177	207	40 M 29 S	255 M 54 S	147 M 54 S
Kenny	12	16	139	175	27 M 20 S	270 M 20 S	135 M 20 S
Tammy	32	28	376	323	89 M 13 S	252 M 59 S	223 M 59 S
Group 1	60	62	692	705	157 M 2 S	270 M 20 S	—
Jeff	22	13	243	145	61 M 14 S	463 M 26 S	111 M 27 S
Josh	25	13	322	185	66 M 25 S	383 M 30 S	127 M 18 S
Emily	44	54	496	674	112 M 46 S	465 M 01 S	465 M 01 S
Group 2	91	80	1061	1004	240 M 25 S	465 M 01 S	—
Total across all participants	151	142	1753	1709	397 M 27 S	735 M 21 S	—

with direct instruction for the group instructional condition, and total amount of group instructional time (direct instruction time plus instruction time where the student was only learning observational targets [e.g., already mastered his or her own targets]). The total number of sessions and trials for a participant to reach mastery criterion was variable across the two teaching conditions; however, across the six participants, targeted skills reached mastery criterion in fewer sessions and fewer trials for the group instructional condition. However, the participants reached mastery criterion in fewer minutes in the one-to-one condition as opposed to the group condition.

## **DISCUSSION**

In this study, we compared the effectiveness, maintenance, observational learning, and efficiency of DTT implemented in a one-to-one instructional format versus DTT implemented in a group instructional format for six 'high functioning' children diagnosed with autistic disorder. Results of the study indicated that both one-to-one instruction and group instruction were effective in teaching children with autistic disorder a variety of targeted behaviors. Additionally, the results indicated that participants' maintenance of skills taught was nearly equivalent for the two instructional formats. An analysis of observational learning indicated that students were partially able to learn targets that were not directly taught to them during group instruction as opposed to targets with which they had no contact. Finally, there were mixed results in terms of efficiency. Participants reached mastery criterion in fewer sessions and trials in the group instructional format; however, the amount of teaching time for participants to acquire targets was substantially longer in the group instructional format. This was due to the fact that in the group instruction condition, there was a total of 30 to 60 trials, across three participants per sessions, where in the one-to-one instructional condition, only 10 trials were implemented per session.

The results of this study are similar to previous research that found DTT to be effective when implemented in a one-to-one instructional format (e.g., Leaf et al., 2010) and to be effective when implemented in a group instructional format (e.g., Taubman et al., 2001). The results of this study are also similar to other research that has compared DTT in the two instructional formats (e.g., Kamps et al., 1990) and found that both formats are effective and that there is mixed results in terms of efficiency across the instructional formats. The results of this study differ from the previous research, however, in that participants displayed less observational learning. Despite this difference, this study helps expand the literature and could help clinicians in several ways.

For one, although previous research has demonstrated that DTT is effective in both one-to-one instructional formats and group instructional formats, many practitioners

still believe that it is inappropriate to teach skills in a group instructional format. Therefore, this research study provides further evidence that such fears about the inappropriateness of group instruction may be unwarranted, as this and other studies have shown that DTT implemented in a group instructional format may be equally as effective as DTT implemented in a one-to-one instructional format.

Second, previous studies compared the implementation of DTT in both instructional formats for children who were more severely impaired while this study evaluated the implementation of DTT in both instructional formats with children who would be considered higher functioning. Thus, this study expands the previous research by targeting a different population. Although clinicians may elect to not implement DTT in a one-to-one instructional setting for higher functioning children with autism, children who are considered higher functioning may still actually need DTT in both group and one-to-one instructional formats. Higher functioning children with autism may require one-to-one instruction to learn new skills that they are having difficulty with, which can then be generalized to the group setting, or skills that will enhance their ability to learn in the group (e.g., learning how to learn skills). This study, however, does show that children may be able to learn targets observationally while participating in group instruction. Therefore, given these results and the potential benefits of group instruction (e.g., allowing for the opportunity for observational learning), teachers, clinicians, and behavior therapists may wish to consider implementing DTT in a group instructional format more frequently, while still considering individual child skill deficits in regard to the implementation of DTT in a one-to-one instructional format.

Despite the positive findings within this study, there are limitations that should be addressed in future research. For one, although participants showed observational learning, it was far below the observational learning demonstrated in previous studies (e.g., Leaf et al., 2011). It is not known why participants displayed lower observational learning in this study as compared with other studies; it is also unknown why observational learning levels decreased between the time when a participant was done with intervention and when all of the participants in a group were done with intervention. It could be that once a participant learned all of his or her skills, they stopped paying as close attention; in some cases, there were several sessions between when a participant mastered all of his or her skills and when the entire group mastered all of their skills. Future experimenters should examine factors that potentially contribute to diminished acquisition of material observationally as well as continue to develop methods to increase observational learning for children diagnosed with autism. One method that may increase observational learning is for teachers to provide reinforcement to participants for good attending when it is not their turn to answer.

Another limitation of this study is the length of time it took two of the participants to acquire skills (e.g., Tammy and Emily). There could be several factors that led these two participants to acquire skills more slowly than the other participants. One

possible reason is the way in which mastery was determined throughout the study. In this study, participants mastered targeted skills when they reached 100% across three consecutive probe sessions. During probe trials participants received no reinforcement for correct behavior, and anecdotally, these two participants seemed to take the lack of affirmation as an indication that they were incorrect, leading to confusion about what was actually the correct response. Future experimenters should find alternative ways to assess mastery of skills that do not inadvertently increase the amount of instructional time needed.

Another limitation is that the researchers only yoked the number of trials across the two conditions if the participant responded correctly on every trial and, therefore, did not yoke the number of remedial trials across the two conditions. This could have led to one condition receiving more remedial trials and, therefore, more opportunities to respond than the second teaching condition. Future researchers may wish to yoke both the number of first opportunity and remedial teaching trials in future studies.

Alongside these limitations, future experimenters may wish to evaluate participant and teacher preference between the two instructional formats. If the two procedures are equal in terms of effectiveness and efficiency, teachers may wish to implement the instructional format that they are most comfortable implementing or implement the instructional format that the participant prefers. An additional area of future research is to compare DTT implemented in a one-to-one instructional format and a group instructional format for children just beginning behavioral intervention. Despite the findings of this study and previous studies, many may still believe that initial behavioral intervention must be implemented in a one-to-one instructional format rather than a group instructional format; future experimenters may wish to explore this question. Additional research may also examine the participant or target characteristics that may differentially affect instructional effectiveness and efficiency within and between the two discrete trial formats. Finally, future experimenters may wish to compare DTT implemented in one-to-one instructional formats, small group instructional formats (as implemented in this study), and large group instructional formats (e.g., six or more children). This information may provide professionals with information on what instructional formats are the most beneficial for children with autistic disorder and what instructional formats are the most cost effective for school districts, schools, and agencies providing behavioral intervention to children and adolescents diagnosed with autistic disorder.

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