EVALUATING THE EFFECTS OF GROUP SIZE ON SKILL ACQUISITION AND REINFORCEMENT

by

ERINN ELIZABETH WHITESIDE

(Under the Direction of Kevin Ayres)

ABSTRACT

Small group instruction (SGI) is an instructional arrangement that can promote academic skill acquisition, social skills, and learning behaviors while optimizing resources and promoting observational learning (Collins et al, 1991; Polloway et al., 1986). Many variables should be considered when designing small group instruction, one of which is group size. This study evaluated the effects of group size on skill acquisition on four elementary age individuals with moderate intellectual disability and autism spectrum disorder. Researchers also examined the relation between group size, rate of reinforcement, and skill acquisition. An adapted alternating treatment design was used to evaluated differences in variables across group size. Results suggest that variables may be influenced by student-specific factors, and researchers should continue to explore foundational variables of SGI to optimize efficiency.

INDEX WORDS: small group instruction, group size, intellectual disability, Autism Spectrum Disorder, skill acquisition, rate of reinforcement

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DEDICATION

I dedicate this to my mother, Laurie Whiteside, and my grandmother, Ann Wilson. Your endless support and love throughout my doctoral program and my life are what often keep me going. Thank you for always listening, for celebrating my successes, and for being my biggest fans. You inspire, you persevere, you encourage, and you overcome. You are wonderful models of independent, intelligent women and I hope to continue to live up to the examples you have set!

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CHAPTER 1

INTRODUCTION

Social learning theory laid the foundation for many lines of research within the fields of education and human behavior. In the 1960s, Bandura recognized that learners may acquire novel responses by observing the behavior and corresponding consequences of others, without ever receiving direct prompting or programmed reinforcement for the response (Bandura, 1961; Bandura, 1977). In special education, researchers have used social learning theory to explain the effects of observational learning in small group instruction. From a behavioral perspective, observational learning may be viewed as a function of motivating operations.

When viewed through a behavior analytic lens, the basic tenets of social learning theory and observational learning can be explained through motivating operations and contingency-specifying stimuli. As students observe behavior of others contact a consequence, the specific behavior of the model may become a discriminative stimulus (S^D) indicating that the consequence is available. This history of observed differential reinforcement, in which the presence of a particular stimulus has resulted in a response being reinforced and the absence of which the same response has not been reinforced, provides a basis for observational learning (Cooper, Heron, & Heward, 2007, p.694). For example, when a peer consistently receives praise after sitting in his chair and orienting to the teacher during group instruction, the same contextual stimuli (e.g., sitting at the table for group instruction with the teacher present) may become an S^D that sitting and orienting to the teacher results in verbal praise. Subsequently, when there is an establishing operation (EO) for teacher attention, the observing student may sit and orient to the

teacher to receive the paired consequence of teacher attention. Programming reinforcement for desired behaviors of all individuals in an environment may permit a teacher to leverage observational learning and increase efficiency of instruction.

Small group instruction (SGI) is traditionally defined within special education as direct instruction of 2-10 students by one instructor, incorporating the use of instructional procedures, prompting, and responding that is individualized for each student (Collins, Gast, Ault, & Wolery, 1991; Ledford, Lane, Elam, & Wolery, 2012;). When designing small group compositions, groups can either be homogeneous, composed of learners with similar characteristics (e.g., age, diagnosis, academic targets), or heterogeneous, composed of learners with varying needs, levels of support, or academic targets (Collins et al., 1991). Researchers have found that in special education settings, most small group instructional arrangements include 3-4 students and are homogeneous in nature (Ledford et al, 2012).

Benefits of SGI

Decades of research on SGI in special education has revealed that a group instructional arrangement can provide both learners and instructors with benefits. Although students receiving special education services frequently participate in 1:1 instruction (Collins et al., 1991; Ledford & Wehby, 2015), SGI can provide advantages over 1:1 instruction. One key advantage of SGI is the optimization of resources, such as reduced materials or increased direct instruction for more students (Polloway, Cronin, & Patton, 1986). Observational learning is another widely cited benefit of SGI, promoting the efficiency of instruction by increasing the opportunities for students to acquire information in a small group instructional arrangement (Doyle, Gast, Wolery, Ault, & Farmer, 1990; Ledford, Gast, Luscre, & Ayres, 2008; Whalen, Schuster, & Hemmeter, 1996). Finally, SGI promotes the development of skills necessary to participate in less intrusive

instructional environments, an advantage that is enhanced through planning and reinforcement of appropriate learning behaviors (Collins et al., 1991, Ledford & Wolery, 2013).

Resources. Teaching in small group arrangements, rather than exclusively in 1:1 settings, saves teachers time and material resources, an advantage that researchers have cited extensively (Collins et al. 1991; Polloway et al., 1996; Quay, 1966). Researchers have found that through SGI, teachers can provide direct instruction to more students, and that students may acquire more skills through observational learning and generalization (Singh, 1987). In 1986, Polloway, Cronin, and Patton reviewed the literature to compare the efficacy of group instruction to 1:1 instruction for both children and adults with intellectual and developmental disabilities. A synthesis of the identified studies revealed that overall, group instruction was equally as effective as 1:1 instruction, but was more efficient because of the number of individuals served at one time. Additionally, Polloway and colleagues concluded that group instruction provided social benefits because learners could also observe the appropriate social behaviors of their peers.

Observational learning. Another benefit of SGI is observational learning, in which students acquire new skills by watching other students engage in a target behavior and receive a consequence for responding (Bandura, 1961). The efficiency of small group instruction through observational learning is exemplified in Ledford, Gast, Luscre, and Ayres (2008) study on observational and incidental learning through small group instruction. Through a multiple-probe design replicated across six students, Ledford et al. demonstrated that with constant time delay and dyadic instructional settings, students not only acquired most of their own instructional targets but also acquired observational information presented throughout instruction. Specifically, students acquired nearly every target explicitly taught to their dyad partner, as well

as the incidental information presented visually to both the individual and the dyad partner contingent on correct responding (89-96% accuracy).

In heterogeneous group settings, students may benefit from observational learning when teachers use different stimuli or tasks for each student, providing opportunities for students to learn additional information by watching the presentation of and response to other students' stimuli (Collins et al. 1991; Collins, 2012). For example, Doyle et al. (1990) compared SGI sessions when the instructor presented students with same-task, same-stimuli and with same-task, different-stimuli. Although students acquired fewer targets in the same-task, different-stimuli condition, the condition required fewer trials, time, and resulted in fewer errors (Doyle et al. 1990). Homogeneous groupings permit students with similar instructional targets and prerequisite skills to observe others learning content relevant to themselves. This may increase efficiency of instruction because the arrangement may also increase the likelihood that teachers will have to differentiate instructional techniques (Collins et al., 1991). The types of groupings available and the student's ability to benefit from those groupings may influence interpretations of the least restrictive environment (LRE) for that student.

Least Restrictive Environment. Federal mandates require that public schools provide students with a free and appropriate public education (FAPE) and serve students in the LRE possible (IDEA, 2004). Because some students lack skills like waiting for a turn, interacting appropriately with peers, and working in environments with lean schedules of reinforcement, they may not receive as much educational benefit from traditional inclusive environments (CEC, 1997; Odom, Buysse, Soukakou, 2011). Working in small group arrangements creates opportunities for students to practice these skills and may also provide opportunities to learn these skills through observation of group members engaging in these skills (Alberto, Jobes,

Sizemore, & Duran, 1980; Collins et al. 1991). By improving these skills, students may demonstrate that they can benefit in less segregated environments and transition into more inclusive settings with less support (Fink & Sandall, 1978).

Current Practices with SGI

Literature on the efficacy of SGI extends across populations, skills, and adaptations, contributing to a strong research base from which practitioners can draw to inform their own practice. Research supports evidence-based practices across populations, including individuals with autism, intellectual disorder, and learning disabilities. Researchers have also evaluated the efficacy of SGI across a variety of skills sets, determining SGI as an effective method of instruction for math, reading, writing, daily living, and social skills. By incorporating adaptations and modifications to SGI, such as prompting strategies and various tools for presenting materials, instructors have enhanced SGI for their students.

Populations. Researchers have evaluated the efficacy of SGI across populations of different disabilities and age. Literature has explored SGI as a method of direct instruction for individuals with intellectual disability (ID) and developmental disability (DD; Aldemir & Gursel, 2014; Garfinkle & Schwartz, 2002; McDonnell, Johnson, Polychronis, Riesen, Kercher, & Jameson, 2006), learning disability (Campbell & Mechling, 2009; Jozwick & Douglas, 2017) autism spectrum disorder (ASD; Leaf et al. 2017; Peters, Tullis, & Gallagher, 2016) and typically developing students (Ledford & Wehby, 2015), all identifying SGI as an effective instructional arrangement for these populations. Literature also supports SGI as an effective instructional method across age groups in school settings, including preschool (Lane, Gast, Shepley, & Ledford, 2015; Ledford & Wolery, 2013; Leaf, Dotson, Oppenheim, Sheldon, & Sherman, 2010), elementary school (Swain, Lane, & Gast, 2015; Chai, 2017), middle school

(Ainsworth, Evmenova, Behrmann, & Jerome, 2016; McDonnell et al. 2006), and high school settings (Doyle, Gast, Wolery, Ault, & Farmer, 1990; Mechling, Gast, & Thompson, 2008). Additionally, instructors have used SGI to provide life skills instruction to adults in postsecondary settings with ASD and developmental disorders (Griffiths, Feldman, & Tough, 1997; Palmen, Didden, & Arts, 2008). Across these populations, teachers use SGI settings to deliver instruction for a spectrum of skills.

Skills. Teachers across educational settings use SGI to teach a variety of skills, including academic skills (i.e., math, reading) as well as skills required to increase independence in daily living (i.e., social skills, grocery shopping). Evidence supports using SGI to facilitate the acquisition of math (Whalen, Schuster, & Hemmeter, 1996), reading (Campbell & Mechling, 2009; Jozwick & Douglas, 2017; Shepley, Lane, & Gast, 2016), and spelling (Purrazzella & Mechling, 2013) skills. Researchers have also targeted social skills through SGI, both as the primary target skill (Leaf, Dotson, Oppenheim, Sheldon, & Sherman, 2010; Ozen, Batu, & Birkan, 2012; Peters, Tullis, & Gallagher, 2016) and through observational learning, instructive feedback, and purposeful group composition (Garfinkle & Schwartz, 2002; Lane, Gast, Shepley, & Ledford, 2015; Ledford & Wehby, 2015; Ledford & Wolery, 2013). Finally, researchers have used SGI to foster daily living skills such as grocery shopping (Mechling, Gast, & Krupa, 2007), dressing (Norman, Collins, & Schuster, 2001) and leisure skills such as playing games (Cattik & Odluyurt, 2017; Kourassanis, Jones, & Fienup, 2015).

Adaptations. Researchers and instructors have modified small group instruction by combining pre-existing strategies and evidence-based practices to accommodate for different learners' needs within a group. Many researchers evaluated different response-prompting strategies within a small group arrangement to determine effective methods of delivering

instruction when working with more than one student at a time (Aldemir & Gursel, 2014; Doyle et al., 1990; Farmer, Gast, Wolery, & Winterling, 1991). As science continues to advance and improve technology, other researchers have explored the efficacy of incorporating new technologies into delivering instruction in small group settings (Mechling, Gast, & Krupa, 2007; Norman, Collins, & Schuster, 2001; Shepley, Lane, & Gast, 2016).

Prompting strategies. Instructors and researchers have combined SGI with a variety of evidence-based response prompting strategies, including physical prompting strategies (i.e., graduated guidance, system of least prompts) time delay prompting strategies (i.e., progressive time delay, constant time delay). For example, in 1990 Doyle et al. evaluated the efficacy of using constant time delay in a small group setting to teach the function of local and federal service agencies, governments, and over-the-counter medications. Using a multiple probe across behaviors design, researchers found that incorporating constant time delay into SGI resulted in acquisition of all targeted skills, as well as promoting observational learning and acquisition of incidental information provided during feedback, without any adaptations to the CTD delivery method. Additionally, researchers determined that instructors could implement the CTD protocol with fidelity within a small group instructional arrangement of 4 students, with average procedural reliability at 95% (Doyle et al., 1990).

Ledford, Lane, Elam, and Wolery (2012) conducted a review of research published between 1990 and 2010 that evaluated the use of response prompting strategies within small group instructional arrangements. Across 47 identified articles, researchers used a variety of prompting procedures with SGI, including constant time delay (30 studies), simultaneous prompting (8 studies), progressive time delay (6 studies), error correction (3 studies), and system of least prompts (1 study) (Ledford et al., 2012). Based on the criteria recommended by Horner

et al. (2005), authors identified response prompting in SGI as an evidence-based practice, with positive results across 47 studies, 197 participants, and 8 distinct research groups (Ledford et al. 2012).

SGI and technology. Technology is constantly advancing and changing, making it more user-friendly, accessible, and affordable (Odom et al. 2015). As a result, several researchers have conducted studies to evaluate the efficacy of incorporating this ever-changing technology into SGI. Earlier studies evaluated the effects of using television and VHS technology during SGI. In 2001, Norman, Collins, and Schuster used video modeling and video prompting, delivered via a television and VCR, to teach self-help skills to three individuals with ID in a small group instructional arrangement. Norman et al. found that video modeling was an effective way to teach the skills to a small group, with two students meeting criteria for all three skills and one student meeting criteria for two skills. Additionally, researchers noted benefits of delivering instruction via videotape, including providing a model of the skill from a student perspective (first-person perspective video), freeing teachers from providing individual prompts to every student, and, with more training, allowing students to provide self-instruction via videotapes.

More recently, researchers have evaluated the efficacy of using instructional tools with touchscreen technology, such as tablets (Chai, 2017; Purrazzella & Mechling, 2013) and interactive whiteboards (Campbell & Mechling, 2009; Mechling, Gast, & Thompson, 2008). For example, Mechling and colleagues compared using SMARTBoard technology to flash cards to deliver sight word instruction in a small group instructional arrangements (Mechling, Gast, & Thompson, 2008). Although both methods of delivering instruction were effective, researchers considered the SMARTBoard technology more socially valid, with participants reporting a preference for learning with the SMARTBoard (Mechling, Gast, & Thompson 2008).

More careful examination of the variables influencing observational learning in small group instruction may benefit practitioners by exploring the behavioral mechanisms underlying observational learning. Some of the hypotheses underlying social learning theory may relate to why students learn via observational learning. For example, observing a peer contact reinforcement may influence the observer's learning. When applied in group instruction, reinforcement following correct responding may increase learning for both target student and observing learners. Observational learning may be more likely to occur in this context if the observing learner has an establishing operation for the observed reinforcement delivered.

The following chapter synthesizes what is known about observational learning within small group instruction, as well as literature supporting the research methodology used to examine these underlying behavioral mechanisms. As a supplement to the study, benefits, variables, and variations of using technology in SGI is evaluated through a literature review of the topic, found in Appendix B. The knowledge and information gained from these demonstration studies sets the foundation for exploring and understanding the underlying process and thus permitting more efficient instructional programming in small group arrangements.

CHAPTER 2

REVIEW OF THE LITERATURE

Small group instruction (SGI) involves direct teaching of 2-10 students by one instructor, incorporating differentiated instructional procedures, prompting, and responding (Collins, Gast, Ault, & Wolery, 1991; Ledford, Lane, Elam, & Wolery, 2012). SGI provides opportunities for observational learning, preservation of resources, and practicing important social and learning skills (Collins et al. 1991; Ledford, Gast, Luscre, & Ayres, 2008; Ledford & Wolery, 2015). Well-planned and organized SGI can capitalize on the appropriate behavior of model students to serve as a discriminative stimulus for other learners. As other students observe the model student respond, they may imitate their responding having seen the consequences for those modeled response.

Researchers have evaluated several variables hypothesized to influence SGI. Some of these variables include adaptations to the instructional delivery method, such as the use of high-tech instructional tools, as well as through the evaluation of various response prompting procedures. In 2012, Ledford et al. (2012) conducted an extensive review of the literature concerning SGI and response prompting procedures, as well as other variables of SGI. One variable of particular interest involves the use of technology. Technology can benefit teachers because it can provide additional learning support and a variety of means of access thus permitting greater participation by learners with disabilities. A thorough review of the literature, found in Appendix B, focuses closely on technology to analyze and summarize the practice of utilizing high-tech instructional technology in special education SGI settings. The present study

utilizes technology as a means of delivering instruction, but focuses on more foundational variables of SGI rather than the use of high-tech tools during SGI. Once the influencing variables of SGI have been identified, that research may be used to continue to evaluate high-tech tools as a means of instruction delivery and further enhance SGI in special education settings. To focus further on the underlying influencing variables of SGI, Ledford et al.'s (2012) review of SGI will be updated and summarized, and additional variables believed to influence SGI will be discussed.

Ledford et al. (2012): An Update

The researcher conducted an extension of Ledford et al.'s (2012) review by replicating the search, using the same search terms and inclusion and exclusion criteria. The search spanned 2010 to 2019 to simply extend and update the search completed by the researchers in the original literature review. A total of 11 articles met the inclusion and exclusion criteria, published between 2013 and 2018 with a total of 43 participants. Like the original review, SGI was found effective for instruction of individuals with disabilities across contexts, content, and variations in implementation. Many variables, variations, and findings reflect the findings of Ledford et al. (2012), including the incorporation of constant time delay (CTD) and progressive time delay (PTD), the use of attending cues during instruction, and participants acquiring peers' targets through observational learning. See Table 1 for a summary of findings from the updated review.

In 2012, Ledford and colleagues suggested future research evaluate promotion of social skills and interactions through SGI. Since their review, several researchers evaluated whether SGI can promote these skills both directly and through observational learning, and whether the skills generalize to other settings. Ledford went on to evaluate SGI's effects on prosocial behaviors by measuring observational learning of sharing, thanking, and empathetic feedback

when modeled by typical peers during group instruction (Ledford & Wolery, 2013; Ledford & Wehby, 2015; Ledford & Wolery, 2015). Results indicated that all participants with disability acquired prosocial behaviors through observational learning in the instructional setting, but generalization to other settings was variable and may require in vivo instruction.

Lane, Gast, Shepley, and Ledford (2015) evaluated the efficacy of teaching peer preferences through incidental feedback and frequency of sharing materials during instruction. Researchers found that participants learned some information about their peers through incidental feedback and that generalization of sharing to other settings was variable, but that participants shared materials with peers independently during instruction by the fourth instructional setting (Lane et al., 2015). In a similar study, Lane, Gast, Ledford, and Shepley (2017) found that direct instruction of peer preferences through a PTD procedure and sharing resulted in mastery of both skills during instruction across six participants in three dyadic instructional settings. Participants maintained and generalized peer preferences, but only one dyad generalized sharing to other settings; another dyad required in vivo sharing instruction across settings, while the third had to terminate generalization trials due to the end of the school year. Most recently, Sweeney, Barton, and Ledford (2018) used PTD within SGI to increase preschoolers' peer imitation behavior. When grouped with typically developing peers, four preschoolers with disabilities increased unprompted peer imitation after direct instruction during sculpting play. When researchers withdrew PTD, peer imitation decreased but did not return to baseline levels.

Other Variables of SGI

In Ledford et al.'s (2012) review of special education SGI arrangements, researchers summarized response prompting procedures used in SGI as well as other variations of SGI. In

addition to incorporating technology, researchers have explored other variables that may influence outcomes of SGI, such as prompting procedures incorporated into SGI, group size, and composition. These variations may be dictated by restricted resources, characteristics or needs of learners, target skills, and group composition.

Response prompting. Response prompting is a stimulus or event provided before or during a response in the presence of the discriminative stimulus, increasing the likelihood that the correct behavior will occur and contact the reinforcer (Cooper, Heron, & Heward, 2007). In 2012, Ledford et al. reviewed the literature around response prompting in SGI, ultimately identifying it as an effective, evidence-based practice. Across studies, researchers effectively used constant time delay (CTD), progressive time delay (PTD), simultaneous prompting (SP), and system of least prompts (SLP) within small-group contexts to teach discrete skills in the areas of reading, math, and social skills. Most studies evaluated or utilized CTD (47%), followed by SP (17%), and PTD (13%). Researchers used SLP less often, with only one study using SLP to teach students words found in a popular restaurant's menu (Doyle, Gast, Wolery, & Ault, 1992).

Since the review's publication in 2012, researchers have continued to evaluate response prompting strategies in a small group instructional setting. In 2015, Ledford and Wehby used PTD in a small group setting to teach academic and social skills to a student with autism and peers at risk of academic failure. Using PTD, researchers successfully taught sight words and geometric shapes to 14 students in dyad or triad groups. Similarly, Chai taught phonological awareness skills to three young children in a rural elementary school setting using CTD (Chai, 2017). Researchers programmed an iPad application to deliver prompts in a CTD format, moving from 0 s to 5 s, to teach identification of phoneme sounds in a triad instructional setting. All

participants met mastery criteria for their target phonemes and independently identified an average of 72% - 89% of groupmates' target phonemes. Ozen, Ergenekon, and Ulke-Kurkcuoglu (2017) used SP to teach receptive identification of household items to four preschool-aged students with developmental disabilities. Students working in dyads correctly identified their own targeted household items, as well as 100% of their partner's targets, after as few as four instructional sessions.

Group size. In SGI, group size typically ranges from 2-10 participants (Collins, Gast, Ault, & Wolery, 1991; Ledford, Lane, Elam, & Wolery, 2012). Although researchers frequently report group size in literature, few have evaluated the effects of different group sizes on variables such as rate of acquisition, reinforcement, or total targets acquired. In 2003, Vaughn et al. evaluated the efficacy of a reading intervention across three different small group sizes. Participants included ninety second-grade struggling readers across 10 elementary schools. Researchers measured participants' reading progress across teacher-to-student ratios of 1:1, 1:3, and 1:10. Data suggest that students made similar progress in the 1:1 and 1:3 groups, and both of these groups were superior to the 1:10 group across measures of reading comprehension, fluency, and phoneme segmentation. McDonnell et al. (2006) later compared 1:1 instruction embedded within typical general education activities to SGI conducted in a self-contained setting. Holding variables such as CTD, differential reinforcement, and error correction constant across settings, researchers evaluated the efficacy of each setting to teach participants to verbally define five sight words tied to the general education curriculum. Researchers found 1:1 embedded instruction and self-contained SGI equally effective in relation to acquisition and generalization of defining the target words.

In the Ledford et al. (2012) review of response prompting in SGI, authors reported group sizes ranging from two to five participants, with groups of three (56%) and four (34%) students reported most commonly. Collins, Gast, Ault, and Wolery (1991) reported similar findings on group size in SGI. After reviewing literature on SGI for individuals with moderate to severe disabilities, authors found researchers reported small group instructional settings as no larger than seven students, and most small groups consisted of 2-4 students. Most recently, Begeny, Levy, and Field (2018) explored literature on reading interventions delivered in SGI to students with reading difficulties and found that across 12 studies, researchers delivered reading interventions to groups ranging from 4-6 students.

Recent literature on SGI report group sizes consistent with the findings of past reviews. In 2014, Rodriguez and Anderson implemented a positive reinforcement total group contingency during academic SGI using groups of 4-5 students. When Chai (2017) evaluated the efficacy of an iPad application in phonemic awareness instruction, she conducted small groups composed of 3 preschool students in a self-contained classroom. Most recently, Saadatzi, Pennington, Welch, and Graham (2018) examined the effects of virtual reality technology and social robotics on sight word instruction in a small group setting, including a small group of three young students and a robot peer.

Acquisition. SGI is an evidence-based practice that results in successful acquisition across a variety of academic domains. Rate of acquisition refers to the number of targets an individual acquires over a specified period of time or number of instructional sessions (Cooper, Heron, & Heward, 2007). In SGI, targets acquired through direct instruction and through observational learning of group mates' targets contribute to the rate of acquisition. Students have successfully acquired all targets during SGI settings, including those composed of dyads (Chiara,

Schuster, Bell, & Wolery, 1995; Holcombe, Wolery, Werts, & Hrenkevich, 1993), triads (Campbell, 2009; Mechling, 2007; Saadatzi, 2018), and larger groups (Colozzi, Ward, & Crotty, 2008; Gursel, Tekin-Iftar, & Bozkurt, 2006; Farmer, Gast, Wolery, & Winterling, 1991), as well as homogenous (Lane et al. 2003; Slavin & Karweit, 1985) and heterogenous (Ledford & Wehby, 2015) group composition. However, few studies have compared the acquisition of targets across group sizes or as compared to 1:1 instruction. Of the few studies that have compared group sizes, researchers have found that 1:1 instruction and small group instruction of up to three students result in similar acquisition of targets, and that both 1:1 instruction and smaller groups of individuals resulted in more efficient acquisition than a small group ratio of 1:10 (McDonnell, 2006; Vaughn et al., 2003).

Reinforcement in SGI. Reinforcement refers to the addition or removal of any stimulus that results in the increase of the behavior immediately preceding the change (Cooper, Heron, & Heward, 2007). Reinforcement in SGI should be purposeful and organized to increase acquisition of target skills, as well as promote acquisition of group members' targets and foster social skills such as attending and waiting in a group setting (Collins et al. 1991). Collins et al. (1991) recommend programmed consequences following student responses to motivate student responding and provide feedback on the response, including individual verbal feedback or feedback paired with tangible reinforcers. Research supports varying methods of reinforcement delivery is successful in small group settings, including delivering reinforcers to individuals or the entire group, and delivering the reinforcer after each correct response or following an entire session.

To date, researchers have not systematically evaluated relative rates of reinforcement and the potential influence on acquisition in a small group instructional setting, although several

researches report programmed consequences in studies evaluating SGI. Shepley et al. (2016) provided verbal praise and images of preferred cartoons on a CRF schedule during SGI with preschoolers, and later modified to include a token economy. Students received tokens on a fixed ratio (FR) 1 reinforcement schedule, trading 10 tokens for a selected tangible reinforcer. Although authors reported schedules of reinforcement for each student, rate of reinforcement (i.e., reinforcers per minute) were not published. More recently, Saadatzi et al. (2018) combined virtual reality and social robotics technologies to teach sight words to elementary students in a small group setting. As with previous researchers, Saadatzi et al. reported schedules of reinforcement (i.e., verbal praise to students for each correct response); rate of reinforcement was not reported.

Basic and translational research in behavior analysis suggest differences in responding and acquisition based on rate of reinforcement. Herrnstein (1961) explored output of responding as a function of rate of reinforcement provided to three male pigeons. The researcher found that as percent of reinforcement increased in one condition, responses allocated to that condition also increased linearly (Herrnstein, 1961). In 1978, Bradshaw Szabadi, and Bevan conducted a study that supported Herrnstein's earlier findings. Bradshaw and colleagues exposed rats to different magnitudes of reinforcers across five different variable interval schedules to assess rates of responding across reinforcement frequency and magnitude. Researchers concluded, among other findings, that rates of responding and frequency of reinforcer delivery increased correlationally (Bradshaw, Szabadi, & Bevan, 1978). Translational research has since gone on to evaluate this correlation within applied settings with human participants. Zanolli and Daggett (1998) manipulated rates of reinforcement during priming sessions for social skills training for social initiations with two preschoolers in a classroom setting. Following the priming sessions,

researchers recorded frequency of spontaneous initiations and found higher rates of spontaneous initiations correlated with the sessions in which students received higher rates of reinforcement.

To set the path for better SGI and evaluate variations of SGI, such as using technology to deliver instruction, some fundamental questions concerning SGI should be explored. Although researchers have conducted extensive research on different variables of SGI and reinforcement separately, limited research evaluates group size and its subsequent effects on rates of acquisition and reinforcement. Further research should focus on the impact of group size on acquisition, and the relationship between acquisition and reinforcement across group sizes. The purpose of the current study is to answer the following research questions: a) What effect does group size have on acquisition of targets? b) What is the relation between rate of reinforcement and acquisition of targets?

Table 1.

Results of an Update to Ledford et al.'s 2012 Review.

Study	Target behavior			OL of group mate targets	Acquisition of IF behaviors	OL of group mate IF	Procedural variations			
	Specified criterion	Generalization	Maintenance				Number of students per group	Target skill	Prosocial behaviors	Attending cues
Saadatzi 2018	■	■	■	■	-	-	2	Sight words	-	General group
Sweeney 2018	-	■			-	-	4	Peer imitation	■	General individual
Chai 2017	■	-	-	■	-	-	3	Initial phonemes	-	General group, individual specific
Lane 2017	■	■	■	-	-	-	2	Peer preferences, sharing	■	Individual general
Ozen 2017	■	■	■	■	-	-	2	Household items	-	Individual general
Shepley 2016	■	■	■	■	■	■	3	Sight words	-	Individual general
Lane 2015	■	■	■	■	■	-	2	Sight words	■	Group general
Ledford 2015 (a)	■	■	■	■	-	-	2-3	Sight words	■	Not specified
Ledford 2015 (b)	■	■	-	■	-	-	3	Sight words	■	Group general
Appelman 2014	■	■	-	■	■	■	2	Sight words	-	Individual general

Ledford 2013	[redacted]	[redacted]	-	[redacted]	-	-	3-4	Sight words, colors	[redacted]	and specific Group general

CHAPTER 3

METHOD

Participants

Four individuals between 9 and 12 years old participated in this study. The researcher recruited all four individuals from a university-operated special education classroom setting based on their history with small group instruction and behavior goals related to attending. Legal guardians provided informed permission for each participant. Inclusion criteria consisted of: (a) a history of successfully participating in a small group setting for at least 10 min, (b) successfully mastered expressive or receptive goals, (c) experience using a token economy, and (d) low levels of problem behavior relative to their classmates. All four participants received special education services at a local public elementary school in a classroom overseen by certified teachers and run by university faculty and graduate students. Each participant received about half of their daily instruction in a 1:1 instructional setting. The other half of instructional time was split between small group and whole group settings, in which instruction was delivered by one instructor but additional instructors monitored and supported each student. See Table 2 for specific assessment scores (i.e., adaptive, IQ) for each participant.

Marcel. Marcel was a 12-year-old, fifth grade African-American male. Marcel received services under a primary eligibility of moderate intellectual disability and a secondary eligibility of speech or language impairment, and received adaptive physical education, occupational therapy, and speech and language services in addition to his placement in a self-contained setting. In his most recent evaluation, approximately 3 years before the study, Marcel scored in the moderately impaired range on the Stanford-Binet 5 (SB5) and exhibited significant adaptive

deficits in the social, conceptual, and practical skill domains on the Adaptive Behavior Assessment System, Third Edition (ABAS-3). Marcel could expressively identify up to 20 community and safety signs, up to 30 sight words related to preferred items or activities, letter sounds, as well as type preferred words from a model, use a calculator to solve single-digit addition and subtraction problems, and follow two-step directions. He functionally communicated wants and needs, as well as likes and dislikes, using four- to five- word sentences. Expressive tasks were selected for Marcel based on his extensive vocal repertoire and history of mastering expressive tasks.

Jamal. Jamal was an 11-year old, fourth grade African-American male. He received special education services under an intellectual disability eligibility with a secondary eligibility of speech-language impairment and received speech and adaptive physical education services. The most recent testing indicated moderate to significant deficits across cognitive and adaptive skills, falling within the moderately impaired range on the Stanford-Binet Intelligence Scale: 5th Edition (SB5) and exhibiting significant adaptive deficits across conceptual, practical, and social domains on the Adaptive Behavior Assessment System - Third Edition (ABAS-3). Jamal could expressively identify up to 10 sight words related to preferred items or activities, letter sounds, and up to 20 community and safety signs, as well as match-to-same and write his name. Expressive tasks were selected for Jamal based on his extensive verbal repertoire and history of mastering expressive tasks.

Andre. Andre was a 10-year old, fourth grade African-American male. Andre received services under an intellectual disability eligibility and a secondary eligibility of speech-language impairment. In addition to the self-contained classroom, Andre received speech and adaptive physical education services. At the most recent evaluation, within two years of the study, Andre

scored in the lower extreme range on both the Differential Ability Scales, 2nd Edition (DAS-2) and the Developmental Profile 3 (DP-3), and scored in the low range in an assessment of adaptive functioning (Vineland Adaptive Behavior Scales, Second Edition (VABS-2)). Andre could match identical objects, expressively identify up to 20 sight words related to preferred words or activities, write his name and preferred item words, follow one-step directions, and count with 1:1 correspondence. Like Marcel and Jamal, expressive tasks were selected for Andre based on his extensive verbal repertoire and history of mastering expressive goals.

Nakeem. Nakeem was a 10-year-old, fourth grade African-American male Nakeem received special education services under a primary eligibility of autism and a secondary eligibility of speech or language impairment, and in addition to self-contained classroom services he also received weekly speech and language services. When initially evaluated, approximately 8 years before the study, Nakeem scored below age level expectations on a cognitive assessment and displayed significant deficits in adaptive areas such as communication, motor, and self-help skills. He used limited functional vocalizations, but functionally used a speech-generating device to communicate wants and needs using two- to three- word sentences. Nakeem could receptively identify over 100 high frequency and preferred-item sight words, count with 1:1 correspondence, use a calculator to solve single-digit addition and subtraction problems, and use his device to spell preferred item words and CVC words when provided with a model. Due to his limited vocal repertoire and the limitations of his SGD, receptive tasks were selected for Nakeem.

Setting

The study took place in a public elementary school in the Southeastern United States, in a self-contained special education classroom operated by a program affiliated with a local university. Specifically, all sessions took place in a small work room across the hall from the

students' typical classroom in which they received daily instruction. The researcher conducted sessions at a long, rectangle-shaped table in the middle of the workroom, identical to tables at which small group instruction typically occurred, which measured 157 cm x 77 cm and could accommodate up to four students at a time. The room in which the table was located contained no decorations or visuals (i.e., Smartboard, visual schedules) that sometimes distracted students during typical instruction. Sessions occurred during times in the daily schedule that students typically participated in academic instruction at different workstations throughout the classroom. The researcher, a certified special education teacher and board-certified behavior analyst (BCBA), provided instruction across all sessions and conditions and also served as the participants' typical classroom teacher and case manager.

Materials

The researcher presented 18 cm x 7.5 cm images (6 cm x 6 cm for receptive ID) of 120 athletes and entertainers using a PowerPoint presentation application on a touchscreen tablet. Targets consisting of famous individuals that may be meaningful to general education same-age peers were selected. Acquisition of these targets would allow the study participants and their general education peers to interact through discussions related to popular media topics. See Table 3 for a list of targets selected for screening. Each color photograph depicted the target in an environment unique to them or engaging with specific items (e.g., LeBron James dunking a basketball) to enhance stimulus control. Images were placed on different colored backgrounds to indicate for which participant the target was intended. The researcher identified a list of 10 different targets for each student and in each condition; images presented to each student per condition are listed in Table 4. Per the participants' typical behavior management protocols, the

students used token boards during each instructional session, and exchanged tokens for preferred edible reinforcers at the end of the instructional session.

Dependent Variables, Response Definitions, and Measurement

The researcher recorded rate of cumulative acquisition by participant as the primary dependent variable. Cumulative target acquisition was defined as the number of targets mastered across all sessions per condition. Targets acquired through direct instruction and observational learning were included in the count of mastered targets. Mastery criteria were independent correct responses within 5 s of presentation during cold probe sessions across three consecutive data points. Another variable that varied as a function group size was the rate of obtained reinforcement. Ratio of programmed reinforcement was set at an FR1, with a single reinforcer delivered with each response. Ratio of obtained reinforcement was recorded as frequency, defined as frequency of reinforcement delivered to a single student during a single session was reported as rate of obtained reinforcement per minute for each participant, calculated by dividing the frequency of reinforcement per session by the duration of the instructional session. For the purpose of this study, the researcher defined reinforcement as the delivery of a token or edible, as outlined in the students' behavior intervention plans.

In addition to cumulative acquisition of targets and rate of reinforcement, the researcher recorded three secondary dependent variables. Peer attention was recorded as frequency per session and defined as any physical or verbal interaction between peers, including positive statements (e.g., "Good job, Jamal!"), negative statements (e.g., "Shut up, leave me alone."), and physical contact (e.g., high five, fist bump). Verbal praise or attention from the instructor (i.e., "Good job!" or "Thanks for looking!") was also recorded, defined as any vocal attention provided to a student outside of target presentations and recorded as duration per occurrence.

Researchers also recorded problem behavior per session. Problem behavior and definitions varied per participant but included aggression, elopement, self-injurious behavior, and disruption. A list of recorded problem behavior, data collection methods, and definitions per participant are located in Table 5. All sessions were video recorded and primary and interobserver agreement data were collected for primary and secondary dependent variables from the video following the sessions. See Appendix A for the data sheet.

Several independent variables were also measured and reported to monitor consistency across sessions and potentially evaluate their impact on the dependent variable. Session length was recorded as the duration of an instructional session, recorded in minutes and seconds. Session duration started when the instructor presented the first stimulus and ended when a reinforcer was delivered following the presentation of the final stimulus. By recording session duration, the researcher could calculate rate of reinforcement, allowing comparison between conditions that lasted different lengths of time. Inter-trial time (ITT) was recorded as the average length of time between presentation of a stimulus to a single student; ITT began at the end of the incidental information for one target and ended when that student's next stimulus was presented.

Interobserver Agreement and Procedural Fidelity

An additional observer independently collected data on participant responding and the instructor's procedural fidelity for at least 30% of all sessions across conditions. Every session was recorded, and observers scored sessions from the video recording. The additional observer was either a masters- or doctoral-level graduate student studying special education and behavior analysis who frequently worked with the children participating in the study. Prior to data collection, each data collector practiced data collection procedures from a video until they became reliable (80% agreement).

Interobserver agreement was calculated using gross IOA for all variables except skill acquisition, in which the researcher divided the data collected by one data collector by the data collected by a secondary data collector and multiplied by 100 (Cooper, Heron, & Heward, 2007). For skill acquisition IOA point-by-point IOA was used, in which the researcher divided the number of agreements by the number of intervals in which both observers scored an occurrence and multiplied by 100 (Cooper, Heron, & Heward, 2007). Overall IOA for all variables averaged 92% agreement. The average IOA agreement was above 95% for all primary dependent variables, but resulted in lower averages for several secondary variables. See Table 6 for specific IOA averages and ranges by variable and participant. Data collectors scored procedural fidelity based on the procedures outline above, including the presentation of stimuli, delivery of reinforcement, and prompting. Procedural fidelity was calculated by dividing the number of steps implemented correctly by the total number of steps. Overall procedural fidelity was 99% accuracy.

Reinforcer Assessment

Prior to the experimental conditions, the researcher ran a reinforcer assessment with each student to evaluate tokens as a reinforcer. The reinforcer assessment was conducted in a concurrent operants arrangement (DeLeon, Fisher, Rodriguez-Catter, Maglieri, Herman, & Marhefka, 2001). Three work stations were set up on a single table in the academic setting. The first included work materials for mastered skills and a token board typically used with each student with spaces for 10 tokens. The second included only work materials, identical to the materials at the first workstation, but with no token board or tokens. The third workstation had no materials. The order in which the stations appeared on the table were randomized with each trial. Each student was brought into the room, explained the contingency of each workstation,

and told, “we need to work for 2 minutes, pick where you’d like to work” before given the opportunity to choose which station they would like to work. The researcher recorded which station students selected with each trial: work with tokens, work without tokens, or the control station that displayed no materials. The reinforcer assessment was administered to each participant individually for three trials per student.

Screening

The researcher screened 120 athletes and entertainers with each participant to create a possible pool of targets for each condition. Procedures for screening were identical those used for cold probe conditions (described later), in which a stimulus and was presented with the S^D, “Who is this?”, and no vocal prompt was given. Screening failure was defined as incorrect response or non-response of a target within 5 s of presentation of the stimuli for two consecutive data points. As a secondary variable, the researcher also screened for incidental information by presenting target-specific $S^{D's}$ such as “what does he/she do?”. Targets that failed screening were randomly assigned to a single student and condition. No target was duplicated across students or conditions.

General Procedures

Regardless of condition, each session started with the instructor stating, “Ok. It’s time to talk about our people.” and presenting the first target to a student with the S^D, “Who is this?”. When students provided an independent, correct response within 5 s of the presentation of the S^D, the instructor provided specific verbal praise (i.e., “Yes, that’s right! Nice work.”). Every student in the session received a token following the presentation of and response to their own target stimulus. After accumulating 10 tokens, students could exchange tokens for a small edible or physical attention (i.e., hug or high five) presented from a reinforcer menu. Verbal praise was

provided throughout the sessions for attending and responding, as well as for correct responses as outlined above.

Duration of each session varied, lasting the time necessary to present 10 targets to each student participating in the session. For example, a 1:1 session would last the length of time needed to present a total of 10 total targets, while a 4:1 session would last the length of time needed to present 40 total targets. The researcher recorded the total duration of each session as a secondary dependent variable. As students mastered targets, new images were pulled from the pool of unknown targets and replaced the mastered images in the set of active targets. Students' current behavior management plans were kept in place across sessions and included differential reinforcement of other behavior and token systems.

Cold Probes

All cold probes took place in a 1:1 arrangement. Cold probes determined what targets students correctly responded to independently prior to instruction. Cold probes occurred at the same location within the classroom as all other sessions, with the teacher across the table from or next to the target student. During cold probes, the instructor presented each stimulus from all conditions to the student one at a time with the S^D, "Who is this?". Once the instructor presented the S^D and the student attended to the stimuli, the instructor allowed 5 s for the student to respond independently. If the student responded correctly, the instructor provided specific verbal praise. Incidental information was accepted as correct responding during probes. If the student responded incorrectly or did not respond, the instructor ignored the response and moved on to the next trial. The instructor did not provide response prompting or error correction during cold probe trials. To differentiate between cold probes and teaching conditions, students received a token for every three presentations, along with verbal praise for sitting and attending to the

stimuli. Students were presented with their own stimuli, as well as stimuli of peers to assess for observational learning. To minimize testing threats, cold probes were conducted once every three sessions.

One-to-One Condition

In the 1:1 condition, the instructor provided instruction to a single student. Sessions took place at the table in the back of the room, with the instructor sitting beside or across from the student at the table. Sessions began when the instructor presented the first stimulus. All 1:1 sessions consisted of teaching trials, in which the instructor used simultaneous prompting (Ozen et al., 2017; Wolery et al. 1993) to immediately gesture or vocally prompt the student to provide the correct response. The student received a token for each presentation, and specific verbal praise for attending and responding. If the student made an error or did not respond, the prompt was repeated up to three times. If the student responded after a follow-up prompt, they received specific verbal praise and a token. If they continued to make an error or not respond, the instructor moved on to the next target and refrained from additional vocal attention and did not provide a token. Incidental information was also provided following the presentation of each target during teaching conditions. The incidental information included a specific fact or detail about each target that could provide the students with more information to use in conversation with peers; the same incidental information was provided per target for each presentation. For example, after presenting Chadwick Boseman, the research may say “He plays Black Panther.”

Dyad Condition

The dyad condition was conducted identically to the 1:1 condition with the exception of two students receiving instruction from a single instructor. Participants for each dyad were randomized at the beginning of the study and then kept constant throughout the study. All stimuli

were presented so that both students could view them, regardless of which student's target was presented. The instructor alternated the presentation of stimuli, with each student receiving direct instruction on their own target with every other presentation. If students praised each other, the praise was recorded separately on the data collection sheet.

Four-to-One Condition

The 4:1 condition was identical to the 1:1 and dyad conditions, except that instructional sessions were conducted with four students and a single instructor. Like in the dyad condition, each stimulus was presented so that all group members could observe the stimulus and tokens were provided to students for attending and responding to their own target presentations. The instructor presented the first stimulus of the session to a student on the far end of the table, then systematically presented all subsequent stimuli to students left to right or right to left so that each student was presented with a target stimuli every fourth presentation.

Experimental Design

An adapted alternating treatment design (Ledford & Gast, 2018) was used to evaluate the effects of group size on acquisition of targets and the relation between rate of reinforcement and acquisition of targets. The researcher randomized the order of conditions each day to control for threats to internal validity (Ledford & Gast, 2018). All conditions were run each day and the sequence was randomized within the day. One cold probe session was run every three days to minimize testing threats.

Table 2.

Participant Scores from Most Recent Eligibility Evaluations

Student	**IQ**	**Parent Scores - Adaptive Skills**	**Teacher Scores - Adaptive Skills**
Jamal	SB5 - 43	ABAS-3 Parent:	ABAS - 3 Teacher:
		General Adaptive = 61	General Adaptive = 62
		Conceptual = 55	Conceptual = 56
		Social = 64	Social = 73
		Practical = 69	Practical = 66
		VABS-II Parent:	VABS-II Teacher:
Andre	DAS - 2: 37	ABC - 60	ABC - 52
	DP-3: General Development	Communication - 56	Communication - 54
	Score - SS - <40	Daily Living - 63	Daily Living - 51
	Cognitive - SS - <50	Socialization - 61	Socialization - 60
Nakeem	DP-3: 50	ABAS-II:	
		Communication - 60	
		Motor Skill - 60	N/A
		Self-Help Skills - 50	
		Social-Emotional - 52	
Marcel	SB5: 42	ABAS-II Parent:	ABAS-II Teacher:
	DAS-II: 36	General Adaptive = 52	General Adaptive = 59
		Conceptual = 53	Conceptual = 63
		Social = 57	Social = 75
		Practical = 54	Practical = 55

Table 3.

List of Targets Selected for Screening.

		Male Actors	Female Actors	Male Athletes	Female Athletes	Male Vocalists	Female Vocalists
		Morgan Freeman	Whoopi Goldberg	Carl Lewis	Wilma Rudolph	Marvin Gaye	Missy Elliott
		Eddie Murphy	Oprah	Mike Tyson	Althea Gibson	Stevie Wonder	Whitney Houston
		Samuel L Jackson	Viola Davis	Hank Aaron	Alice Coachman	Al Green	Tina Turner
	African - American	James Earl Jones	Octavia Spencer	Magic Johnson	Jackie Joyner	Prince	Diana Ross
		Will Smith	Halle Berry	Jerry Rice	Sheryl Swoopes	Darius Rucker	Janet Jackson
		Tom Kenny	Meryl Streep	Wayne Gretsky	Jenny Thompson	Paul McCartney	Madonna
		Robert Downey Jr	Maggie Smith	Joe Montana	Annika Sorenstam	Elvis Presley	Dolly Parton
	Caucasian	Stan Lee	Sandra Bullock	Brett Favre	Tonya Harding	Freddie Mercury	Shania Twain
		George Lopez	Salma Hayek	Pele	Nancy Lopez	Carlos Santana	Shakira
Over 50	**Hispanic**	Antonio Banderas	Jennifer Lopez	Alex Rodriguez	Maria Bueno	Ricky Martin	Gloria Estefan
		Wayne Brady	Zendaya	LeBron James	Serena Williams	Donald Glover	Beyonce
		Chadwick Boseman	Queen Latifa	Tiger Woods	Gabby Douglas	Usher	Nicki Minaj
		Kevin Hart	Raven-Simone	Kobe Bryant	Simone Biles	Frank Ocean	Rihanna
Under 50	**African - American**	Tyler Perry	Taraji P. Henson	Usain Bolt	Aja Wilson	Drake	Ella Mai

	Michael B. Jordan	Jennifer Hudson	Cam Newton	Brittney Griner	Khalid	Alicia Keys
	Grant Palmer	Grey DeLisle	Michael Phelps	Mia Hamm	Justin Timberlake	Adele
	Alex Thorne	Harley Bird	Conor McGregor	Danica Patrick	Adam Levine	Taylor Swift
Caucasian	Tom Holland	Jennifer Lawrence	Tom Brady	Lindsey Vonn	Ed Sheeran	Lady Gaga
	Riley Lio	America Ferrera	David Silva	Maya Dirado	Enrique Iglesias	Selena Gomez
Hispanic	Jake T. Austin	Sofia Vergara	Rafael Nadal	Daniella Rosas	Romeo Santos	Ariana Grande

Table 4.

List of Targets Assigned to Each Participant and Condition.

Marcel	1:1 Condition	Tina Turner Danica Patrick	LeBron James Jerry Rice	Wayne Gretzky Ella Mai	Halle Berry Missy Elliott	Rihanna Tyler Perry	Maya Dirado Sheryl Swoopes	Antonio Banderas
	2:1 Condition	Alex Thorne Dolly Parton	Zendaya Queen Latifah	Jennifer Lawrence Janet Jackson	Lindsey Vonn Prince	Raven Symone Viola Davis	Stevie Wonder	Chadwick Boseman
	4:1 Condition	Oprah Grant Palmer	Hank Aaron Eddie Murphy	Alice Coachman Darius Rucker	Sofia Vergara George Lopez	Whitney Houston	Mike Tyson	Tom Holland
Jamal	1:1 Condition	Drake Tom Kenny Usher	Ed Sheeran Marvin Gaye Mia Hamm	Danica Patrick Salma Hayek	Jennifer Lawrence Freddie Mercury	Taylor Swift Adam Levine	Elvis Presley Lindsey Vonn	Althea Gibson Ella Mai
	2:1 Condition	Romeo Santos Nicki Minaj	Ariana Grande Daniella Rosas	Stevie Wonder Sandra Bullock	Rihanna David Silva	Magic Johnson Will Smith	Robert Downey, Jr. Aja Wilson	Morgan Freeman
	4:1 Condition	Whoopi Goldberg Paul McCartney	James Earl Jones Tonya Harding	Beyonce Al Green	Kobe Bryant	Jake Austin	Simone Biles	Lady Gaga
Andre	1:1 Condition	Usher	Alex Thorne	Michael B. Jordan	Donald Glover	Halle Berry	Mia Hamm	Gabby Douglas

		America Ferrera	Cam Newton	Riley Lio				
	2:1 Condition	Brittney Griner	Alicia Keys	Wilma Rudolph	Wayne Gretzky	Prince	Stan Lee	Tom Holland
		Tiger Woods	Carlos Santana	Tina Turner				
	4:1 Condition	Alex Rodriguez	Selena Gomez	Jennifer Hudson	Kevin Hart	Maggie Smith	Khalid	Harley Bird
		Ricky Martin	Usain Bolt	Meryl Streep	Adele			
Nakeem	1:1 Condition	Prince	Samuel L. Jackson	Ed Sheeran	Tina Turner	Nicki Minaj	Riley Lio	Danica Patrick
		Halle Berry	Michael B. Jordan	Salma Hayek	Althea Gibson	Sheryl Swoopes	Jennifer Lopez	
	2:1 Condition	Aja Wilson	Shakira	Brittney Griner	Gabby Douglas	Robert Downey, Jr.	Marvin Gaye	Wayne Brady
		Alicia Keys	Mia Hamm	Will Smith				
	4:1 Condition	Serena Williams	Nancy Lopez	Diana Ross	Carl Lewis	Pele	Enrique Iglesias	Grey DeLisle
		Octavia Spencer	Taraji Henson	Justin Timberlake	Jackie Joyner			

Table 5.

Definitions and measurement of problem behavior.

Target Behavior	Definition	Data Collection	Student
Aggression	Pinching; biting; open- or closed-handed strike to another person from a distance of six inches or more; contact with a any part of the leg or head from a distance of six inches or more; throwing an object within a three foot radius of another person; spitting in the direction of another person; contact between his hand and the hair of another person	Frequency, reported as rate per session	Jamal Andre Nakeem Marcel
Disruption	Pushing, throwing or kicking an object more than six inches or touching an object from a distance of 6 inches in 2 seconds or less	Frequency, reported as rate per session	Jamal Andre Marcel
Elopement	Being more than one foot away from the designated area without permission from a staff member	Frequency, reported as rate per session	Jamal Andre Nakeem Marcel
Self-Injurious Behavior	Touching any part of his body with his mouth; open- or closed-handed strike to his own body from a distance of six inches or more	Frequency, reported as rate per session	Jamal Nakeem Marcel

Table 6.

IOA results by variable and participant. Variables and numbers in bold represent primary variables.

		1:1		2:1		4:1		Overall
		Average	Range	Average	Range	Average	Range	Average
Marcel	**Session Duration**	**98.25%**	**97% - 99%**	**99.25%**	**98% - 100%**	**99.5%**	**99% - 100%**	**99%**
	Reinforcer	**100%**	--	**100%**	--	**100%**	--	**100%**
	Cold Probe	**100%**	--					**100%**
	Instructor Attention	81.25	63% - 100%	65.5%	35% - 90%	58%	37% - 98%	68.25%
	Peer Attention	--	--	62.5%	0% - 100%	77%	28% - 100%	69.75%
	ITT	82.9%	48% - 100%	95.25%	89% - 100%	97%	94% - 99%	91.72%
	Problem Behavior	75%	0% - 100%	100%	--	80%	24% - 100%	85%
Jamal	**Session Duration**	**99.25%**	**98% - 100%**	**99.83%**	**99%-100%**	**99.5%**	**99%-100%**	**99.53%**
	Reinforcer	**100%**	--	**100%**	--	**100%**	--	**100%**
	Cold Probe	**100%**	--					**100%**
	Instructor Attention	62.88%	41% - 82%	62.5%	35%- 97%	56%	32%-88%	60.29%
	Peer Attention	--	--	41%	0%-100%	61%	39%-88%	51%
	ITT	77.83%	57% - 100%	92.75%	89%-99%	97%	89%-99.6%	89%
	Problem Behavior	75%	0% - 100%	94%	50%-100%	67%	0%-100%	79%
	Session Duration	**99.5%**	**99%-100%**	**99.63%**	**99%-100%**	**99.5%**	**99%-100%**	**99.54%**
	Reinforcer	**100%**	--	**100%**	--	**100%**	--	**100%**

	Cold Probe	**100%**	**--**					**100%**
Andre	Instructor Attention	64.88%	43%-93%	63.75%	40%-89%	54%	38%-75%	60.78%
	Peer Attention	--	--	47%	0%-100%	71%	50%-100%	59%
	ITT	83.88%	70%-92%	96.25%	89%-100%	99%	97%-100%	92.98%
	Problem Behavior	100%	--	100%	--	100%	--	100%
	Session Duration	**95.88%**	**83%-100%**	**99.25%**	**98%-100%**	**99.5%**	**99%-100%**	**98.21%**
	Reinforcer	**99%**	**91%-100%**	**99%**	**91%-100%**	**99%**	**92%-100%**	**99%**
	Cold Probe	**98%**	**91%-100%**					**98%**
Nakeem	Instructor Attention	70.88%	50%-87%	59.38%	48%-87%	57%	39%-92%	62.37%
	Peer Attention	--	--	63%	0%-100%	61%	0%-100%	62%
	ITT	86.63%	64%-100%	93.88%	92%-97%	99%	98%-100%	93.17%
	Problem Behavior	100%	--	100%	--	86%	0%-100%	95%

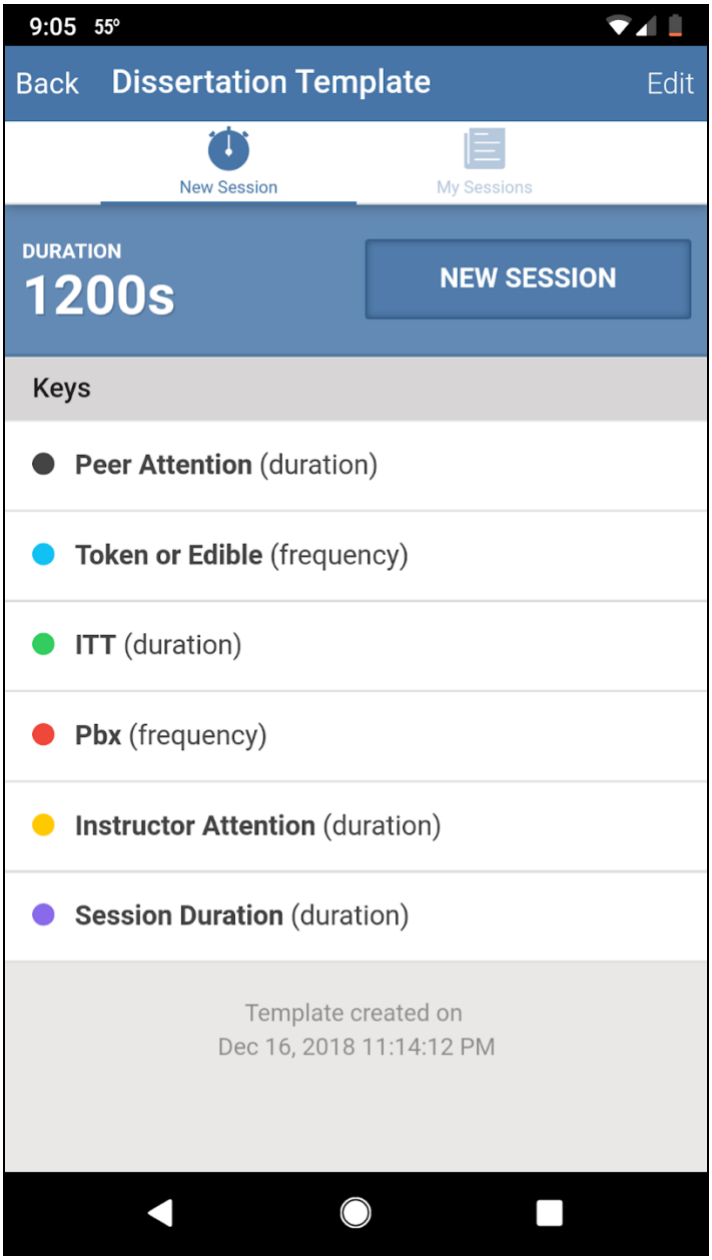

Figure 1. Countee template for data collection.

CHAPTER 4

RESULTS

The purpose of the study was to answer the following research questions: a) What effect does size of instructional group have on individual acquisition of learning targets? b) What is the relation between rate of reinforcement and acquisition of targets? To answer the research questions, the researcher conducted 24 teaching sessions and 8 cold probes in each condition. Data were collected in both teaching trials and cold probe sessions, and results varied by participant. Table 7 summarizes the data for all dependent variables by condition.

Rate of Cumulative Target Acquisition

1 to 1 condition. Across all participants, instruction in the 1:1 condition resulted in mastery of 23 targets after a total cumulative instruction time of 156.4 min (see Tables 8-11 for a list of specific targets mastered). Marcel averaged 5.6 min of instruction per mastered target, Jamal averaged 3.5 min per mastered target, and Nakeem averaged 7 min per mastered target. Andre did not master any targets in the 1:1 condition. See Tables 8-11 for specific targets mastered, total mastered targets per participant, and cumulative instruction time.

2 to 1 condition. The four participants mastered a total of 20 targets after a total cumulative instruction time of 163.7 min in the 2:1 condition. Marcel and Nakeem received instruction together in a dyad for a total of 74.3 min. Marcel averaged 10.6 min of instruction per mastered target in this instructional arrangement, and Nakeem averaged 18.6 min. Jamal and Andre received instruction together for a total of 89.5 min. Jamal averaged 9.9 min of instruction per mastered target, and Andre did not master any targets in this condition. See Tables 8-11 for a

list of mastered targets and specification between mastery of assigned targets and peers' targets for all participants and conditions.

4 to 1 condition. Small group instruction of all participants resulted in total mastery of 24 targets after 176.6 min of instruction. Marcel and Jamal both averaged 25.2 min of instruction per mastered target in this instructional arrangement. Andre averaged 88.3 min of instruction per mastered target, and Nakeem averaged 22.1 min. See Figures 2 and 3 for graphs depicting acquisition of targets across conditions per participant.

Rate of Obtained Reinforcement

The 1:1 condition resulted in the densest schedule of obtained reinforcement, with an average of 6.8 reinforcers delivered per minute. As expected, the 2:1 condition resulted in reinforcers delivered half as frequently, with an average across participants of 3.3 reinforcers delivered per minute and an overall group rate that averaged 7.2 reinforcers per minute (for Marcel and Nakeem) and 6 reinforcers per minute (for Jamal and Andre). The 4:1 conditioned resulted in the leanest rate of obtained reinforcement, with an average of 1.5 reinforcers delivered per participant per minute. The overall rate of obtained reinforcement (number of reinforcers delivered to all participants per minute) in the 4:1 condition averaged 5.8 reinforcers per minute. Tables 8 - 11 summarize the rate of reinforcement for each participant by condition.

Peer attention. Although the researcher did not conduct assessments to establish whether peer attention functioned as a reinforcer, data were collected to evaluate the potential reinforcing or distracting effects of peer attention on skill acquisition. Across dyads, participants received peer attention during an average of 3% of the session. The 4:1 condition resulted in much more peer attention, with participants receiving attention during an average of 12% of the session.

Across conditions, Jamal and Andre received more peer attention than Marcel and Nakeem. See Tables 8-11 for the average percent of sessions each student received peer attention by condition.

Teacher attention. Like peer attention, the researcher did not assess the reinforcing effects of teacher attention but collected data to evaluate the potential correlation between teacher attention and skill acquisition as a reinforcer. In the 1:1 condition, participants received teacher attention for an average of 30% per session. Dyad conditions resulted in an average of 19% of teacher attention per session per participant, and in the 4:1 condition participants received teacher attention for an average of 12% of sessions. See Tables 8-11 for the average percent of sessions each participant received teacher attention, listed by condition.

Other Variables

The researcher also collected data on two other variables in an attempt to evaluate other potential variables of change between different group sizes. These data are summarized by condition in Table 7 and displayed by participant in Tables 8-11. Although not directly related to the research questions, these variables may provide additional insight into the differences between outcomes for each group size.

Inter-trial time. Inter-trial time was collected by averaging the amount of time participants waited between presentation of targets and were very similar for each participant across conditions. In the 1:1 condition, participants waited an average of 2.2 s between target presentations. ITT was nearly five times as long in the 2:1 condition, with participants waiting an average of 10.9 s between trials. In the 4:1 condition, participants waited an average of 34.8 s between presentation of trials.

Rate of problem behavior. The researcher calculated the rate of problem behavior by dividing the frequency of problem behavior by the duration of each session and resulted in very

different rates for each participant. Marcel engaged in the most problem behavior in the 2:1 condition (.88/minute), followed by the 4:1 condition (0.5/min) and the 1:1 condition (0.28/minute). Jamal's results differed, with the most instances of problem behavior in the 4:1 condition (0.35/min), with less problem behavior in the 2:1 condition (0.15/min) and 1:1 condition (0.14/min). Andre also engaged in problem behavior most frequently in the 4:1 condition (0.14/minute), with near-zero levels of problem behavior in the 2:1 condition (0.05/minute) and the 1:1 condition (0.02/minute). Nakeem engaged in the least amount of problem behavior of all participants, engaging in only 0.03/min in the 4:1 condition, 0.01/min in the 2:1 condition, and no problem behavior in the 1:1 condition. Tables 8-11 summarize rates of problem behavior for each participant by condition. See Figures 4 and 5 for graphs depicting problem behavior across conditions per participants.

Instructional feedback. In addition to target information, instructional feedback was provided after each target across condition. Marcel acquired the incidental information for four targets in the 1:1 condition, six targets in the 2:1 condition (two through OL), and 11 targets in the 4:1 condition (seven through OL). Jamal acquired the incidental information for five targets in the 1:1 condition, two in the 2:1 condition (one through OL), and five in the 4:1 condition, all of which were through OL. Andre acquired incidental information for five targets overall, two in the 1:1 condition, two in the 2:1 condition (one through OL), and one in the 4:1 condition. Nakeem acquired incidental information only in the 1:1 condition, in which he learned two, and the 4:1 condition, in which he also learned two (one through OL).

Table 7.

Averages across sessions and participants for each dependent variable, by condition.

Condition	Total Mastered Targets	Average Minutes of Instruction / Mastered Target	Cumulative Instruction Time	Average Percent of Session - Peer	Average Percent of Session - Teacher	Average ITT / Session	Average Rate of PBX / Session
1:1	23	6.8 Minutes	156.4 Minutes	N/A	30%	2.2 s	.11 / Minute
2:1	20	8.2 Minutes	163.7 Minutes	3%	19%	11.2 s	.27 / Minute
4:1	24	7.4 Minutes	176.6 Minutes	12%	12%	35.6 s	.26 / Minute

Table 8.

Results for each dependent variable for Marcel.

	Assigned Target	Peer Target	Total	Average Rate of SR+	Average Percent of Session - Peer	Average Percent of Session - Teacher	Average ITT / Session	Average Rate of PBX / Session
1:1	Tina Turner LeBron James Danica Patrick Jerry Rice Wayne Gretzky Tyler Perry Sheryl Swoopes	N/A	7	6.8 / Minute	N/A	30%	2.4 s	.28 / Minute
2:1	Raven Symone Lindsey Vonn Jennifer Lawrence Stevie Wonder	Will Smith Robert Downey Jr. Mia Hamm	7	3.6 / Minute	1%	21%	9.6 s	.88 / Minute
4:1	Hank Aaron Mike Tyson Oprah Eddie Murphy	Whoopi Goldberg Beyoncé Octavia Spencer	7	1.5 / Minute	10%	15%	34.8 s	.5 / Minute

Table 9.

Results for each dependent variable for Jamal.

	Assigned Target	Peer Target	Total	Average Rate of SR+	Average Percent of Session - Peer	Average Percent of Session - Teacher	Average ITT / Session	Average Rate of PBX / Session
1:1	Drake Ed Sheeran Danica Patrick Jennifer Lawrence Taylor Swift Elvis Presley Tom Kenny Marvin Gaye Freddie Mercury Mia Hamm Adam Levine	N/A	11	7.1 / Minute	N/A	28%	2 s	.14 / Minute
2:1	Romeo Santos Stevie Wonder Morgan Freeman Nicki Minaj	Prince Stan Lee Alicia Keys Wilma Rudolph Tiger Woods	9	3 / Minute	6%	17%	12 s	.15 / Minute
4:1	Whoopi Goldberg James Earl Jones Beyoncé Paul McCartney Lady Gaga	Darius Rucker Meryl Streep	7	1.4 / Minute	17%	11%	35.1 s	.34 / Minute

Table 10.

Results for each dependent variable for Andre.

	Assigned Target	Peer Target	Total	Average Rate of SR+	Average Percent of Session - Peer	Average Percent of Session - Teacher	Average ITT / Session	Average Rate of PBX / Session
1:1	None	N/A	0	6.1 / Minute	N/A	33%	2.3 s	.02 / Minute
2:1	None	None	0	3 / Minute	5%	21%	11.5 s	.05 / Minute
4:1	Harley Bird	Hank Aaron	2	1.4 / Minute	17%	14%	33.3 s	.14 / Minute

Table 11.

Results for each dependent variable for Nakeem.

	Assigned Target	Peer Target	Total	Average Rate of SR+	Average Percent of Session - Peer	Average Percent of Session - Teacher	Average ITT / Session	Average Rate of PBX / Session
1:1	Tina Turner Prince Riley Lio Halle Berry Salma Hayek	N/A	5	7.3 / Minute	N/A	27%	1.9 s	0 / Minute
2:1	Robert Downey Jr.	Zendaya Alex Thorne Queen Latifah	4	3.6 / Minute	1%	15%	10.9 s	.01 / Minute
4:1	Diana Ross Justin Timberlake	Whitney Houston Jennifer Hudson Khalid Ricky Martin Meryl Streep Adele	8	1.5 / Minute	3%	9%	36.7 s	.03 / Minute

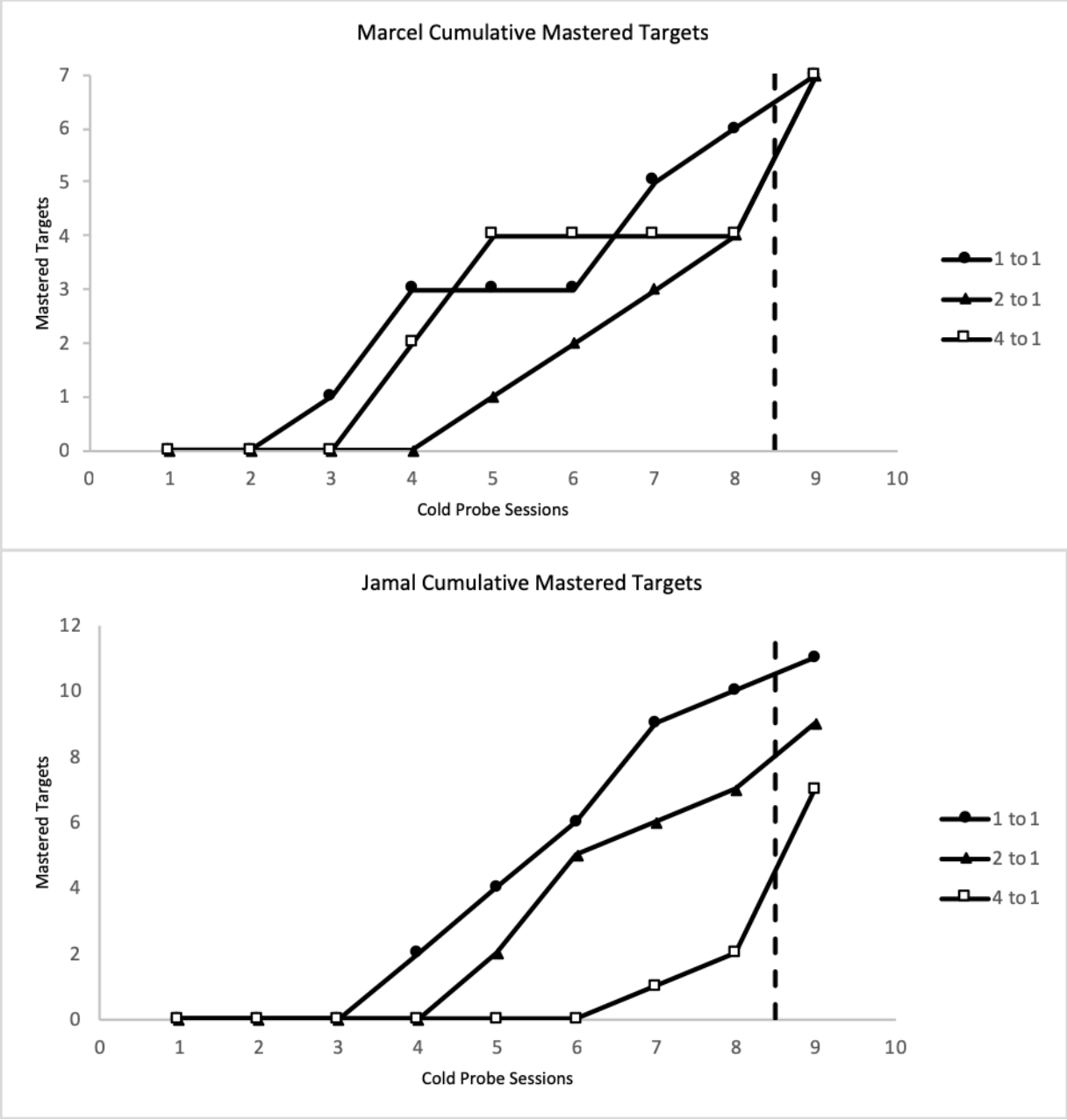

Figure 2. Cumulative mastered targets across conditions for Marcel and Jamal (both expressive).

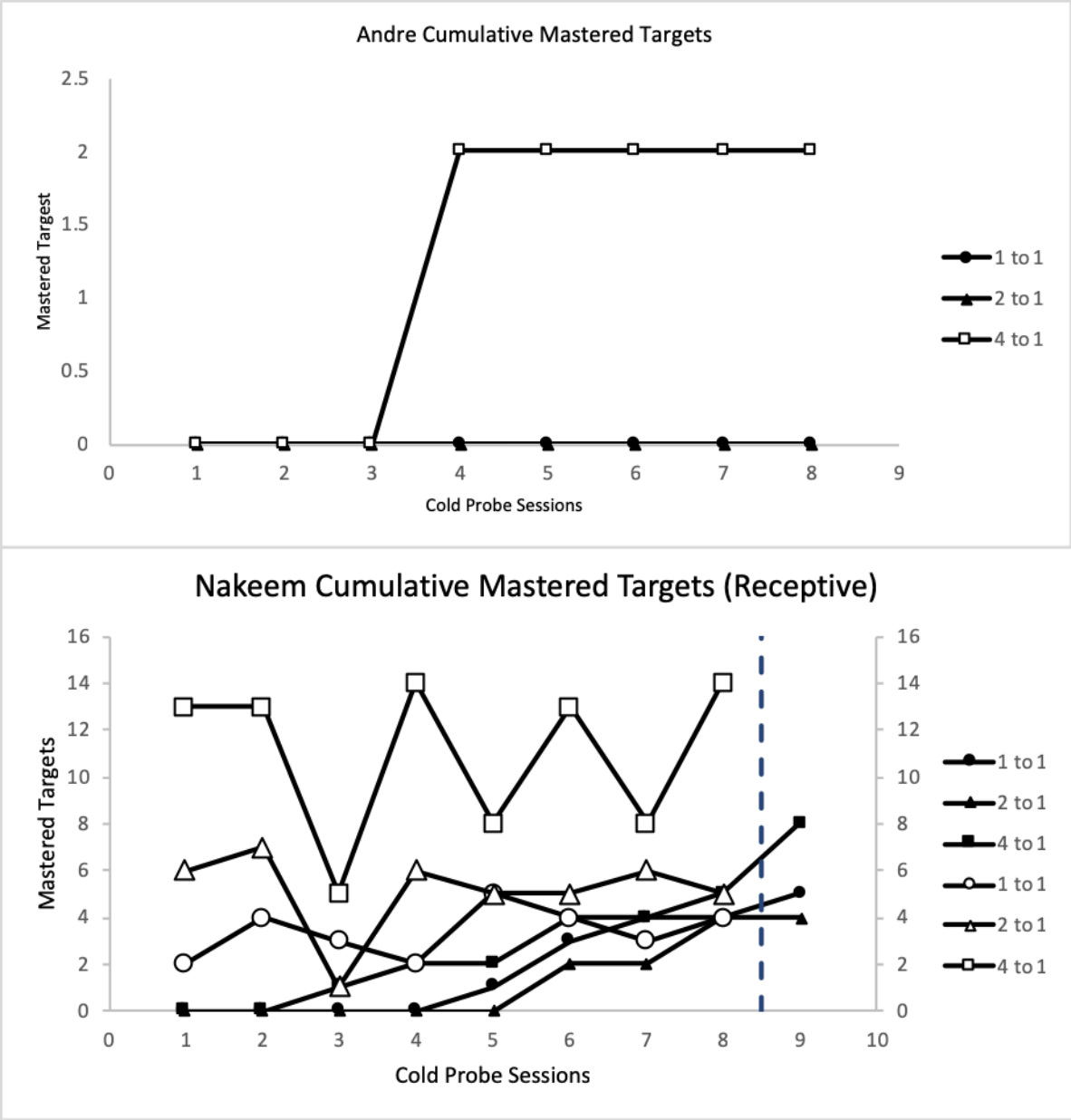

Figure 3. Cumulative mastered targets across conditions for Andre (expressive) and cumulative and correct targets across conditions for Nakeem (receptive).

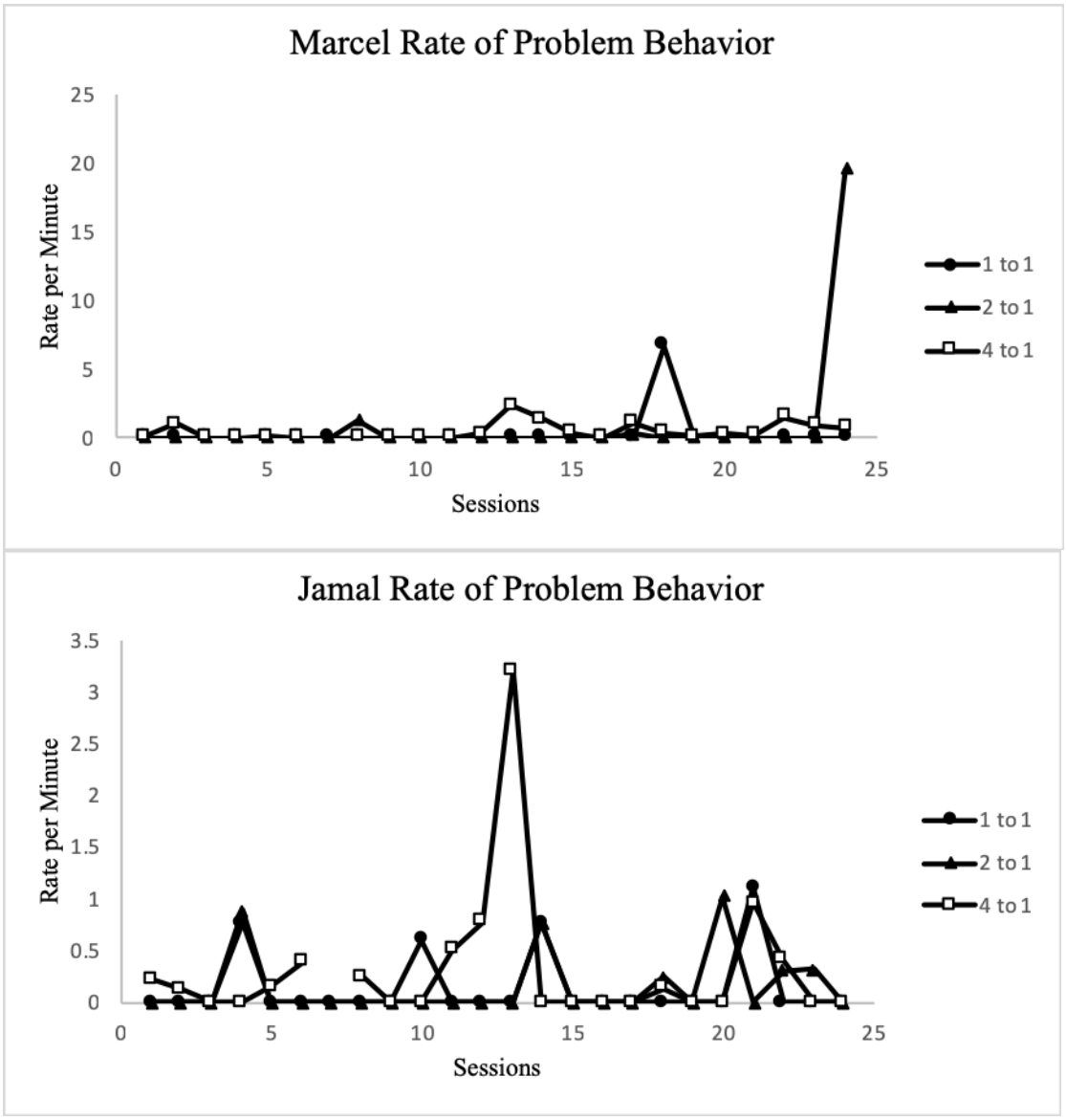

Figure 4. Problem behavior across conditions for Marcel and Jamal.

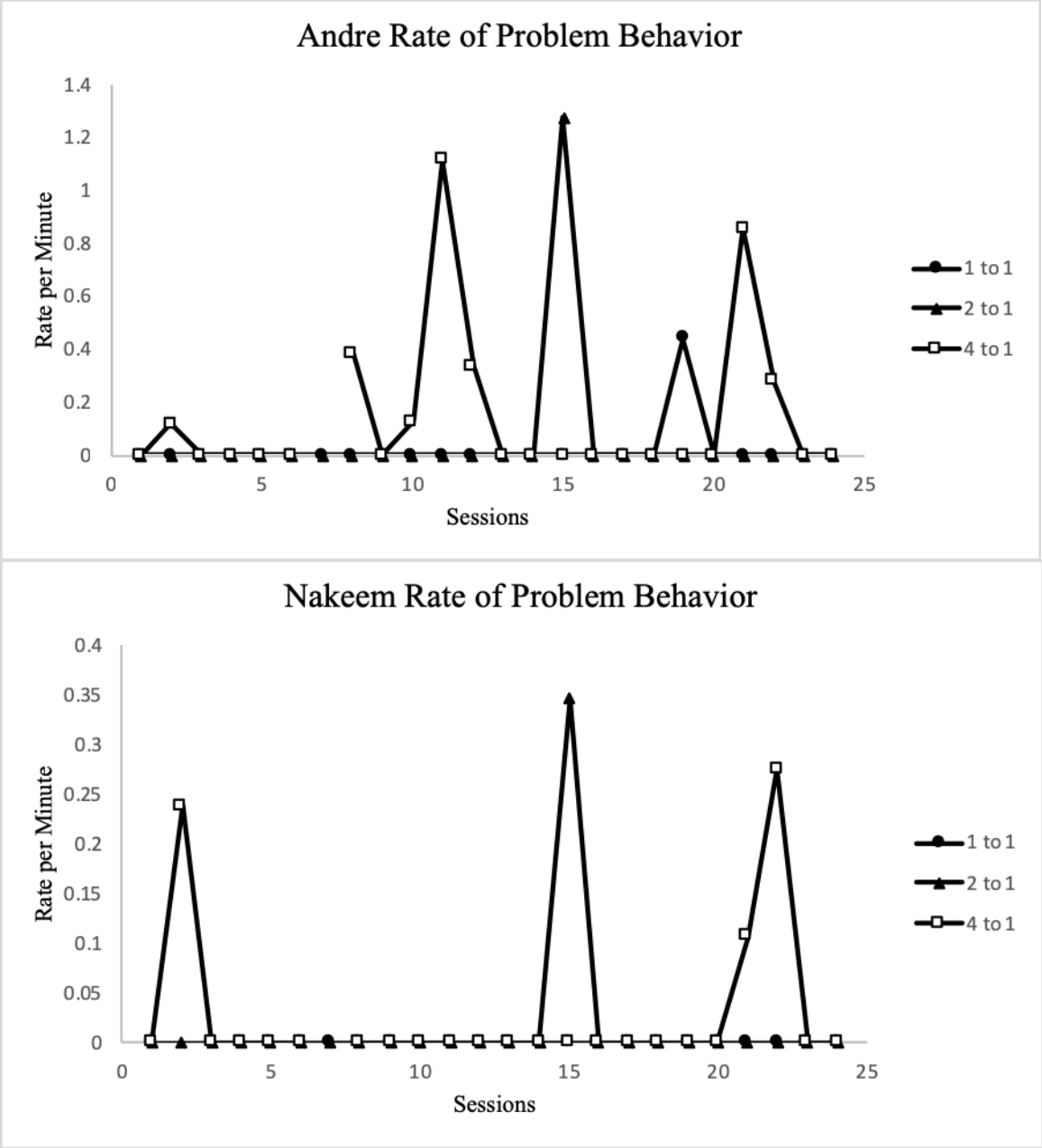

Figure 5. Problem behavior across conditions for Andre and Nakeem.

CHAPTER 5

DISCUSSION

Social learning theory suggests that observing others respond to instructional stimuli and receive a consequence for correct responding may result in observational learning, in which an individual acquires the peer's targets without receiving direct instruction or corresponding consequences (Bandura, 1977). Although many researchers have explored and confirmed this phenomenon, observational learning does not necessarily result in more efficient instruction in small group settings, as demonstrated through the current study. Further, few studies to date have manipulated group size to identify variables that influence the effectiveness of SGI. The current study explores foundational variables of SGI, rate of obtained reinforcement and group size, and evaluates their effects on skill acquisition, peer and teacher attention, rate of problem behavior, and ITT. The study sought to extend the research in this area by identifying variables that influence the efficacy of SGI, allowing future researchers to manipulate these variables to increase the efficiency of SGI in self-contained settings. The findings of this study suggest that variables of influence may be idiosyncratic, indicating that instructors should plan and adapt SGI based on specific qualities of the participants.

Overall, 1:1 instruction resulted in the most efficient instruction with an overall average of 6.8 min of instruction per mastered target across participants. Interestingly, 4:1 instruction was next in efficiency, averaging 7.4 min of instruction per mastered target across participants. The 2:1 condition was the least efficient in skill acquisition at 8.2 min per target. Although the difference in minutes is minimal, with an overall difference of 1.4 minutes, these differences

could have more of an impact on instruction when considered over the course of a student's school year. Vannest and Hagan-Burke (2010) conducted a survey to explore how special educators spend their time and found that approximately 30.2% of teacher time is spent on instruction (i.e., academic instruction, instructional support). Across a 7-hour school day, this would result in 127 minutes of instruction a day. Over the course of a school year, that student can receive up to 380 hours of academic instruction. Using averages from the current study, a student would average approximately 3,408 mastered targets in 1:1 instruction, 2,784 mastered targets in 2:1 instruction, and 3,085 mastered targets in 4:1 instruction. On this scale, differences in efficiency may be more severe, and the impact more meaningful.

Both basic and translational literature suggest that rate of reinforcement and rate of responding are positively correlated (Bradshaw, Szabadi, & Bevan, 1978; Hernstein, 1961; Zanolli & Daggett, 1998). However, in the current study, rates of obtained reinforcement did not align with correct responding across conditions, nor did they align with other potentially related variables. This finding suggests that variables other than programmed reinforcement may account for acquisition for each participant. For example, the difference between average rate of obtained reinforcement across conditions (6.8/min to 3.3/min to 1.5/min in the 1:1, 2:1, and 4:1 conditions, respectively) did not align with the difference between cumulative acquired targets per condition (23 targets, 20 targets, and 24 targets). Similarly, variables such as peer attention and problem behavior, did not align with the differences in ITT across sessions. For Marcel, the average rate of problem behavior was higher in the 2:1 condition, more than three times as much ITT in the 4:1 session.

Limitations

Several limitations of the study require discussion. First, assessments were not conducted on preference for teacher attention, peer attention, and preference to a token economy as it compares to teacher and peer attention. Differences in responding across conditions may be explained by preferences for attention or token economies, and could explain variations by participant. For example, if peer attention is a more valuable reinforcer to one student than tokens, peer attention or problem behavior may compete with attending to the instructional stimuli and therefore result in slower acquisition of targets in the group instruction conditions for those students. Alternatively, if teacher attention or tokens compete with peer attention, students receiving those as consequences for attending may perform as well in the group instruction as they do in the individual instruction conditions. Assessments prior to instruction related to these preferences may serve to explain these variations in responding across conditions.

Preference for targets or difficulty of targets randomly assigned to conditions may have served as an artifact unrelated to group size and instruction. Although the researcher attempted to identify targets of equal difficulty, some may serve as more challenging to say or acquire for some students than others, resulting in slower acquisition rates in the conditions to which those targets were randomized. Similarly, many targets were selected based on their ties to preferred television shows, movies, and music. Targets related to high-interest topics may have been more quickly acquired because of their associations, leading to faster rates of acquisition in those randomly assigned conditions. Random assignments were reviewed and edited to account for these threats, but preference and difficulty may still have influenced target acquisition within certain conditions.

Problem behavior throughout sessions, although a measured variable, is another limitation to the study. Three of the four participants have a history of engaging in high-intensity problem behavior towards instructors and low-intensity problem behavior towards peers, and engage in problem behavior throughout the study. Running SGI with such a homogeneous composition may have limited skill acquisition, as problem behavior may have served as a distractor during instruction. Future research may consider comparing homogeneous and heterogeneous SGI composition for individuals who engage in problem behavior to compare the differences in skill acquisition and problem behavior across compositions.

Readers should also interpret the results with caution due to some factors concerning interobserver agreement scores. First, because of the gross IOA method, variables with very small numbers may result in very low IOA calculations, despite being only seconds apart. For example, if the primary observer scored 3 s of peer attention and the secondary observer scored 5 s of peer attention, that is a difference of only 2 s but will yield an IOA agreement score of 60%, which is considered fairly low. This may be addressed through a more detailed IOA calculation method, or by imposing rules such as a range of seconds being acceptable. Another limitation related to IOA is the IOA scores for peer attention and teacher attention. The variability in topography of these behaviors complicated agreement for these behaviors, although a consensus was met upon discussion between the two coders for each session and participant. This was considered acceptable for this particular study, as peer and teacher attention were not primary dependent variables and decisions were not made based on these data. However, future research may consider more detailed collection of these data, such as noting timestamps of target behaviors (Gast & Ledford, 2018).

Other limitations relate to student-specific responding. One limitation, related to Nakeem specifically, is related to the targets selected for instruction. Nakeem's correct responding was variable, as seen in Figure X, which may suggest that some mastery is a result of chance. Some researchers have found that individuals with autism may have trouble discriminating the salient features of faces (Nickl-Jockschat et al. 2015; Schultz, 2005). On other receptive tasks, such as receptive identification of community signs or Dolch sight words, Nakeem averages between 3 and 6 teaching days before mastery. As the only participant with receptive responding and an eligibility of ASD, and considering the rapid rate of acquisition with which the participant typically acquires receptive tasks, this phenomenon may explain the inconsistency in responding during the study. Thus, his results should be considered with caution.

Another limitation specifically pertains to Andre. A testing threat may have compromised the internal validity of Andre's results. During screening sessions, Andre responded to targets by identifying each target as "boy" or "girl." Per protocol, he received tokens on an FR3 schedule for responding and verbal praise throughout for attending, sitting, and responding. Andre responded similarly during probe sessions, which were conducted the same way as the screening sessions in which he received tokens and verbal praise for responding with "boy" and "girl." The reinforcement received in the screening sessions may have been sufficient to maintain similar responding during probe sessions, despite the teaching trials exposing the participant to the correct answers between probe sessions and especially if Andre rarely came into contact with the differential reinforcement provided for correct responding during probes.

Future Research

Results of the current study present idiosyncratically, with the most efficient condition presenting differently with each participant. These variations may be the result of individual

differences for each participant unrelated to instruction, such as function of problem behavior, preference of reinforcer, targeted skills. Future research may focus on developing a brief assessment to consider these individual differences and determine an instructional arrangement that will optimize acquisition based on idiosyncratic variables.

Researchers should also continue to focus on other foundational variables that may affect the efficacy of SGI. One such variable is attention to the instructor or peers across group size. Attending to the instructor, rather than instructor attention provided to individual participants, may provide more insight into variables influencing acquisition and the differences between acquisitions across group sizes. Evaluating attending to peers, whether during responding or during ITT, and the specific peer behaviors participants attend, may also provide important information on influencing variables of SGI and perhaps even on the composition of small groups. On a similar note, researchers should explore what behaviors occur during ITT, if those behaviors change in topography or frequency as ITT increases, and to what extent attending or non-attending behaviors impact cold probes directly following each session.

Some components of SGI that are typical during the participants' regular instruction, such as error correction during probes and praise for responding to peers' targets when appropriate were excluded from the study's protocols to avoid confounding variables. However, future research may consider incorporating such components to avoid testing threats, as was possible in Andre's results, or evaluate potential increases in responding, compliance, and acquisition of targets. As these components are those frequently used within classroom instruction (Pennington & Courtade, 2015; Reinke, Lewis-Palmer, & Martin, 2007), a component analysis may be an informative in identifying influential components of SGI.

Finally, the current study did not program for or evaluate SGI's effects on prosocial behaviors acquired through group learning. As recommended by Ledford et al. (2012), future research should continue to explore the efficacy of teaching prosocial skills through SGI, either through direct instruction, incidental feedback, or observational learning. Although 1:1 instruction resulted in more effective rates of acquisition across participants, SGI is unique in that it provides opportunities to practice prosocial skills in vivo and with a variety of peers in a structured setting (Collins et al., 1991; Polloway et al., 1986). Although rate of academic targets may be slower or more variable, SGI may be more appropriate for students who would benefit from increased exposure to prosocial behavior and opportunities to respond.

While the current study demonstrated that 1:1 instruction results in more efficient rates of acquisition, it should be noted that the researcher does not recommend that teachers deliver instruction exclusively in a 1:1 setting. SGI provides other benefits in a classroom, such as opportunities to practice prosocial behaviors and learning behaviors, such as waiting turns, attending to the instructor during ITT, and working under leaner rates of reinforcement. Instead, researchers should continue to explore foundational variables of SGI and strategies to manipulate these variables to promote more efficient SGI.

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APPENDICES

Appendix A: Data Sheets

Marcel Screening / Cold Probes **Primary / IOA**

Marcel	**Date**							
4:1 Direct	Oprah							
	Hank Aaron							
	Alice Coachman							
	Frank Ocean							
	Sofia Vergara							
	Whitney Houston							
	Mike Tyson							
	Tom Holland							
	Grant Palmer							
	Eddie Murphy							
	Darius Rucker							
	George Lopez							
2:1 Direct	Alex Thorne							
	Zendaya							
	Jennifer Lawrence							
	Lindsey Vonn							
	Raven Symone							
	Stevie Wonder							
	Chadwick Boseman							
	Dolly Parton							
	Queen Latifah							
	Janet Jackson							
	Prince							
	Viola Davis							

	Tina Turner							
	Lebron James							
	Wayne Gretzky							
	Halle Berry							
	Rihanna							
	Maya Dirado							
	Antonio Banderas							
	Danica Patrick							
	Jerry Rice							
	Ella Mai							
	MIssy Elliott							
	Tyler Perry							
1:1 Direct	Sheryl Swoopes							
	Whoopi Goldberg							
	James Earl Jones							
	Beyonce							
	Kobe Bryant							
	Jake Austin							
	Simone Biles							
	Lady Gaga							
	Paul McCartney							
	Tonya Harding							
	Al Green							
	Alex Rodriguez							
	Selena Gomez							
	Jennifer Hudson							
4:1 OL	Kevin Hart							

	Maggie Smith							
	Khalid							
	Harley Bird							
	Ricky Martin							
	Usain Bolt							
	Meryl Streep							
	Adele							
	Serena Williams							
	Nancy Lopez							
	Diana Ross							
	Carl Lewis							
	Pele							
	Enrique Iglesias							
	Grey DeLisle							
	Octavia Spencer							
	Taraji Henson							
	Justin Timberlake							
	Jackie Joyner							
	Aja Wilson							
	Shakira							
	Brittney Griner							
	Gabby Douglas							
	Robert Downey Jr.							
	Marvin Gaye							
	Wayne Brady							
	Alicia Keys							
2:1 OL	Mia Hamm							

	Will Smith							

Jamal Screening / Cold Probes **Primary / IOA**

Jamal	**Date**							
	Whoopi Goldberg							
	James Earl Jones							
	Beyonce							
	Kobe Bryant							
	Jake Austin							
	Simone Biles							
	Lady Gaga							
	Paul McCartney							
	Tonya Harding							
4:1 Direct	Al Green							
	Romeo Santos							
	Ariana Grande							
	Stevie Wonder							
	Rihanna							
	Magic Johnson							
	Robert Downey Jr.							
	Morgan Freeman							
	Nicki Minaj							
	Daniella Rosas							
	Sandra Bullock							
	David Silva							
	Will Smith							
2:1 Direct	Aja Wilson							
	Drake							
	Ed Sheeran							
	Danica Patrick							
	Jennifer Lawrence							
	Taylor Swift							
1:1 Direct	Elvis Presley							

	Althea Gibson							
	Tom Kenny							
	Marvin Gaye							
	Salma Hayek							
	Freddie Mercury							
	Adam Levine							
	Lindsey Vonn							
	Ella Mai							
	Usher							
	Mia Hamm							
	Oprah							
	Hank Aaron							
	Alice Coachman							
	Frank Ocean							
	Sofia Vergara							
	Whitney Houston							
	Mike Tyson							
	Tom Holland							
	Grant Palmer							
	Eddie Murphy							
	Darius Rucker							
	George Lopez							
	Alex Rodriguez							
	Selena Gomez							
	Jennifer Hudson							
	Kevin Hart							
	Maggie Smith							
	Khalid							
	Harley Bird							
	Ricky Martin							
4:1 OL	Usain Bolt							

	Meryl Streep							
	Adele							
	Serena Williams							
	Nancy Lopez							
	Diana Ross							
	Carl Lewis							
	Pele							
	Enrique Iglesias							
	Grey DeLisle							
	Octavia Spencer							
	Taraji Henson							
	Justin Timberlake							
	Jackie Joyner							
	Brittney Griner							
	Alicia Keys							
	Wilma Rudolph							
	Wayne Gretzky							
	Prince							
	Stan Lee							
	Tom Holland							
	Tiger Woods							
	Carlos Santana							
2:1 OL	Tina Turner							

Andre Screening / Cold Probes **Primary / IOA**

Andre	**Date**							
	Alex Rodriguez							
	Selena Gomez							
	Jennifer Hudson							
	Kevin Hart							
	Maggie Smith							
	Khalid							
	Harley Bird							
	Ricky Martin							
	Usain Bolt							
	Meryl Streep							
4:1 Direct	Adele							
	Brittney Griner							
	Alicia Keys							
	Wilma Rudolph							
	Wayne Gretzky							
	Prince							
	Stan Lee							
	Tom Holland							
	Tiger Woods							
	Carlos Santana							
2:1 Direct	Tina Turner							
	Usher							
	Alex Thorne							
	Michael B. Jordan							
	Donald Glover							
	Halle Berry							
	Mia Hamm							
	Gabby Douglas							
1:1 Direct	America Ferrera							

	Cam Newton							
	Riley Lio							
	Oprah							
	Hank Aaron							
	Alice Coachman							
	Frank Ocean							
	Sofia Vergara							
	Whitney Houston							
	Mike Tyson							
	Tom Holland							
	Grant Palmer							
	Eddie Murphy							
	Darius Rucker							
	Whoopi Goldberg							
	James Earl Jones							
	Beyonce							
	Kobe Bryant							
	Jake Austin							
	Simone Biles							
	Lady Gaga							
	Paul McCartney							
	Tonya Harding							
	Al Green							
	Nancy Lopez							
	Diana Ross							
	Pele							
	Enrique Iglesias							
	Grey DeLisle							
	Octavia Spencer							
4:1 OL	Taraji Henson							

	Justin Timberlake							
	Romeo Santos							
	Ariana Grande							
	Stevie Wonder							
	Rihanna							
	Morgan Freeman							
	Nicki Minaj							
	Daniella Rosas							
2:1 OL	Sandra Bullock							

Nakeem Screening / Cold Probes Primary / IOA

Nakeem	**Date**							
	Serena Williams							
	Nancy Lopez							
	Diana Ross							
	Carl Lewis							
	Pele							
	Enrique Iglesias							
	Grey DeLisle							
	Octavia Spencer							
	Taraji Henson							
	Justin Timberlake							
4:1 Direct	Jackie Joyner							
	Aja Wilson							
	Shakira							
	Brittney Griner							
	Gabby Douglas							
	Robert Downey Jr.							
	Marvin Gaye							
	Wayne Brady							
	Alicia Keys							
	Mia Hamm							
2:1 Direct	Will Smith							
	Prince							
	Samuel L. Jackson							
	Ed Sheeran							
	Tina Turner							
	Nicki Minaj							
	Riley Lio							
	Danica Patrick							
1:1 Direct	Halle Berry							

	Michael B. Jordan							
	Salma Hayek							
	Althea Gibson							
	Sheryl Swoopes							
	Jennifer Lopez							
	Oprah							
	Hank Aaron							
	Alice Coachman							
	Frank Ocean							
	Sofia Vergara							
	Whitney Houston							
	Mike Tyson							
	Tom Holland							
	Grant Palmer							
	Eddie Murphy							
	Darius Rucker							
	George Lopez							
	Whoopi Goldberg							
	James Earl Jones							
	Beyonce							
	Kobe Bryant							
	Jake Austin							
	Simone Biles							
	Lady Gaga							
	Paul McCartney							
	Tonya Harding							
	Al Green							
	Alex Rodriguez							
	Selena Gomez							
4:1 OL	Jennifer Hudson							

	Kevin Hart							
	Maggie Smith							
	Khalid							
	Harley Bird							
	Ricky Martin							
	Usain Bolt							
	Meryl Streep							
	Adele							
	Alex Thorne							
	Zendaya							
	Jennifer Lawrence							
	Lindsey Vonn							
	Raven Symone							
	Stevie Wonder							
	Chadwick Boseman							
	Dolly Parton							
	Queen Latifah							
	Janet Jackson							
2:1 OL								

Screening / Cold Probe Data Sheets

Key:

Correct +

Correct (IF) ◯

Incorrect --

Procedural Fidelity Data Sheets

1:1	Student Initials:							
	Session #:							
1	One student sitting with the instructor.							
2	No other materials on the table.							
3	Statement made to start the sessions / asked what they want to work for.							
4	Reinforcement provided for responding.							
5	Praise for pro-social behaviors and responding.							
6	Edible given for 10 tokens.							
7	SD repeated at least 3 times for nonresponses.							
8	Bx plans followed for pbx.							
9	Ensures student is attending / looks at stimuli before presenting SD.							
	Total							

2:1	Student Grouping:						
	Session #:						
1	Two students sitting with the instructor.						
2	No other materials on the table.						
3	Statement made to start the sessions / asked what they want to work for.						
4	Reinforcement provided for responding.						
5	Praise for pro-social behaviors and responding.						
6	Edible given for 10 tokens.						
7	SD repeated at least 3 times for nonresponses.						
8	Bx plans followed for pbx.						
9	Direct instruction NOT provided for peer's targets.						
10	Ensures student is attending / looks at stimuli before presenting SD.						
	Total:						

4:1	4:1 Condition						
	Session #:						
1	Four students sitting with the instructor.						
2	No other materials on the table.						
3	Statement made to start the sessions / asked what they want to work for.						
4	Reinforcement provided for responding.						
5	Praise for pro-social behaviors and responding.						
6	Edible given for 10 tokens.						
7	SD repeated at least 3 times for nonresponses.						
8	Bx plans followed for pbx.						
9	Direct instruction NOT provided for peer's targets.						
10	Ensures student is attending / looks at stimuli before presenting SD.						
	Total:						

Cold Probes	Student Initials:						
	Cold Probe #:						
1	One student sitting with the instructor.						
2	No other materials on the table.						
3	Statement made to start the sessions / asked what they want to work for.						
4	Specific praise provided for correct responding.						
5	Praise for pro-social behaviors and responding.						
6	Token provided every 3 targets.						
7	Edible provided every 10 tokens.						
8	Bx plans followed for pbx.						
9	Ensures student is attending / looks at stimuli before presenting SD.						
	Total:						

Appendix B: Technology and Group Instruction Literature Review

SGI and Technology

Instructional technology refers to any tools used to help facilitate instruction; high-tech instructional tools specifically refers to technology such as video, computers, interactive screens, tablets, and phones (Elicin & Kaya, 2017). Instructional technology can provide advantages to users, such as supporting independence and providing adaptations for individuals with speech, hearing, visual, or intellectual disabilities (ID) to enable better access to instruction (Hasselbring & Glaser, 2000). A unique benefit of using high-tech (computer-based) devices to facilitate instruction is that, unlike low-tech tools (i.e., pencils, books, whiteboards), high-tech tools have a programmable or autonomous nature, and can provide instruction, reinforcement, or collect data in place of more typical human instructors. Additionally, high-tech tools have become more popular and accessible; for example, the U.S. Department of Education (2010) reported wide use of interactive whiteboards (IWB), such as SMART Boards, in public school classrooms.

Computer- and video-based technology have been found effective tools for instruction of individuals with autism and other developmental disabilities. As early as the 1980s, researchers have evaluated the use of both computer-based instruction (e.g., Baumgart, 1987) and video-based instruction (e.g., Charlop, 1989) in school settings. Researchers have evaluated these instructional tools for participants with a variety of disabilities, including ID, autism spectrum disorder (ASD), and other developmental disabilities (Ploog, Scharf, & Nelson, 2013; Ramdoss et al, 2012) and for teaching a variety of content, such as math (O'Malley, Lewis, Donehower, & Stone, 2014; Yakubova, Hughes, & Shinaberry, 2016), reading (Browder, Root, Wood, & Allison, 2017; Kim, McKenna, & Park, 2017), and self-help or independent living skills (Gardner & Wolfe, 2015; Johnson, Blood, Freeman, & Simmons, 2013). Furthermore,

researchers have reported that academic instruction incorporating high-tech instructional tools is more efficient than teacher-only instruction (Pennington, 2010). Researchers have also evaluated the efficacy of computer- and video-based technology to promote social skills, increase desired behaviors, and decrease problem behavior across settings (Flower, 2014). Generally, literature on the effectiveness of instructional technology in special education has been assessed in direct instruction arrangements with a single educator and one learner (1:1) or in independent, self-instruction arrangements.

Special education teachers often use 1:1 direct instruction to teach specific skills and behaviors to individuals with disabilities (Gilson, Carter, & Biggs, 2017; Wong et al. 2015). This method of instruction is widely researched and recommended for these learners who often require individualized and intensive instruction (Stahmer, Collings, & Palinkas, 2005). While this arrangement permits effective instruction, direct 1:1 instruction is not always an efficient use of resources nor does it allow for opportunities for observational learning or social interactions through instructional integration of students (Kamps, Walker, Locke, Delquadri, & Hall, 1990).

Direct instruction can also be conducted in small group arrangements, defined here as an arrangement in which instructors use evidence-based practices to deliver instruction to a group of heterogenous or homogenous learners that make up less than an entire class but more than a single individual (Collins, Gast, Ault, & Wolery, 1991). Generally, research involving small group arrangements have included between 2-5 students, with most studies including 3 or 4 students per group (Ledford, Lane, Elam, & Wolery, 2012). Small group instruction provides benefits to the learner not applicable for 1:1 instruction, such as the opportunity to learn observationally by watching peers engage in a behavior and the consequences that follow that behavior (Bandura, 1977) and to engage with their peers. Researchers have reported that small

group instruction can promote observational learning in students with autism (Plavnick & Hume, 2014) and other developmental disabilities (Collins et al., 1991). Other advantages of small group instruction include benefits to the staff, including efficient use of instructors' time and instructional materials, increased instructional time with students, and adherence with the mandate of least restrictive environments by providing instruction with peers whenever possible (Kamps et al. 1990).

Small-group instruction has been most frequently assessed for teaching sight word identification; other frequently-researched behaviors in the literature include answering factual questions and expressively identifying pictures or other stimuli (Ledford et al., 2012). Researchers have also assessed student learning of math computation, receptive identification, play skills, spelling, and social initiations. In small group instructional arrangements, students often acquired additional information via instructional feedback and observational learning of peers' targets and instructional feedback (Ledford et al., 2012). Thus, small group arrangements often led to *efficient* learning, in which students learned target behaviors and extra non-targeted information.

Ledford et al. 2012 reported that researchers used variety of instructional procedures during small group instruction, including constant time delay (CTD), progressive time delay, simultaneous prompting, system of least prompts, and error correction; with CTD used most frequently. Ledford and colleagues did not report the extent to which studies included high-tech instructional tools, although several EBP's incorporating technology via high-tech mediums have been identified, such as video-based instruction (Hong, Ganz, Ninci, Neely, Gilliland, & Boles, 2015) and computer-based instruction (Hasselbring & Glaser, 2000; Mechling, 2008).

Because of Ledford's recent review, the purpose of this review is to specifically evaluate computer- and video-based technology used in an instructional small group arrangement. Specifically, the following questions were explored: 1) What types of high-tech instructional materials have researchers evaluated in small group arrangements, and what were the effects? 2) How have researchers used technology to deliver or facilitate instruction? 3) Have researchers used technology to overcome some of the limitations of small group instruction, such as limited opportunities to respond?

Method

The first author performed a search to identify articles using the PsycINFO and ERIC databases. The search terms used in both databases were (*small group* OR *dyad* OR *triad)* AND (*technology* OR *computer* OR *video)* AND (*special education* OR *autism* OR *developmental disability* OR *mental retardation* OR *autism spectrum disorder)*. Search limitations included availability in English; searches were not limited to peer-reviewed journals or specific years (all studies up to April 2018), and included gray literature. Initially, the researchers screened abstracts for potential articles; authors then conducted a full-text review of articles identified through the initial screening to identify studies based on the inclusion criteria.

Researchers included studies based on the following criteria: (a) instruction provided to students receiving special education services; (b) specific references to instruction provided in a small-group or whole-group format; (c) high-tech instructional materials (e.g., tablet, computer, video, IWB) included as at least one independent variable; (d) instruction was provided to pre-kindergarten through 12th grade students; and (e) the use of an experimental design to evaluate effect. The authors defined experimental designs as those in which researchers controlled for independent variables and provided opportunities for replication of effects. Studies that included

a group of students receiving individual instruction simultaneously via computer (i.e., a class in a computer lab) were excluded. A total of 14 articles met all criteria for inclusion, 11 via the electronic database search and 3 via an ancestral search.

Authors coded each single case design separately for descriptive information, as well as quality and rigor. For example, an article with three multiple probe across behaviors designs (one for each of three participants), would be coded as three separate experiments rather than a single study. Descriptive data coded included: demographic information, type of technology used, whether the technology-based instructional materials were commercially-made or teacher-made, topography of responses, rate of opportunities to respond (OTRs), additional uses of the technology (e.g., to deliver reinforcement of prompting), whether preference was reported, whether observational learning and acquisition of instructional feedback was reported, and content of instruction. Articles were coded using the Single-Case Analysis and Review Framework (SCARF, Ledford, Lane, Zimmerman, Chazin, & Ayres, 2016; Zimmerman, Ledford, Severini, Pustejocksy, Barton, & Lloyd, 2018) to assess the quality and rigor of each study; the SCARF codes draw on Horner et al. (2005), Council for Exceptional Children (2014), and standards developed by What Works Clearinghouse and provide a visual representation of the state of evidence. These scores are determined through factors such as the number of demonstrations of effect, sufficient data points, collection of interobserver agreement and procedural fidelity, outcomes, and measurement of generalization and maintenance. A second coder reviewed 36% of the identified articles and collected interobserver agreement data by separately coding the articles for demographic information, technology and response variables, and SCARF codes. Overall mean interobserver agreement across codes was 86.1% (76% - 96%).

Discrepancies were identified and resolved through discussions between the two coders, and all final codes are a result of these discussions.

Results

Authors identified 14 studies, including 42 experiments and 46 participants, with studies published across 16 years (2001 to 2017).Of these 14 studies, 12 were published in peer review journals. At the time of the search, the remaining 2 studies were unpublished dissertations available through online databases.

Participants and Setting

Included participants spanned preschool to high school instructional settings (age range: 3-21 years). Some studies reported only diagnoses of participants, while others reported special education eligibilities under which the student receives services; some included both, and some reported multiple diagnoses or eligibilities per participant. Reported diagnoses and eligibilities included ASD (41%), pervasive developmental disorder not otherwise specified (PDD-NOS; 2%), ID (29%), cerebral palsy (CP; 4%), Down Syndrome (DS; 15%), learning disability (LD) or specific learning disability (SLD; 20%), developmental disability (DD; 4%), and significant developmental delay (SDD; 4%), with ASD the most common diagnosis or eligibility (see Table X for specific participant demographics).

Instruction was delivered by the researcher in 57% of the studies; in 14% of the studies a researcher who also served as the regular primary instructor for the participants implemented instruction. The remaining 29% of studies did not specify the instructional agent. Instruction most often occurred in participants' typical instructional setting, such as a self-contained (29%) and resource classrooms (7%) in a public elementary school, university-sponsored high school

transition programs (29%), or university-based education settings (14%); it sometimes occurred in university-based or private practice clinics (14%), or the participants' home (7%; see Table 2).

Touchscreen Technology

Skills and materials. Sixty-five percent of studies evaluated the use of touchscreen technology in small group instructional settings. These studies examined IWB (36%) and tablets (29%) as mediums of delivering instruction. Across the studies, this subset of high-tech instructional tools was used with individuals in preschool, elementary, and high school transition program settings to facilitate instruction in literacy (e.g., letter sounds, phonemes, building sentences, reading and matching sight words, and spelling), social (e.g., social engagement, communicative turn taking) and leisure (e.g., gaming) skills.

To support instruction, 89% of the touchscreen technology studies incorporated additional software into the design of instructional materials, including PowerPoint (67%) and educational applications, or "apps" (22%). The final study included the use of an IWB to access web-based educational games. Of the supplemental technology tools, most were designed by instructors or researchers (e.g., designed the PowerPoint presentations, designed an app; 88%). Others used commercially-designed applications or web-based games (22%).

Responding and prompting. Of the touchscreen technology studies, nearly half (44%) incorporated the unique features of the technology into response topographies by asking students to respond via interaction with the touchscreen interfaces of the tablets or IWB. The touchscreen technology was more commonly utilized with tablets (75% of studies using tablets) than with IWB (20% of studies using IWB). The remaining studies evaluating touchscreen technology required response topographies including expressive identification (e.g., saying the answer without physically interacting with the technology; 55%), receptive identification (e.g., pointing

to the correct answer without using the touch screen features; 22%), or performing a specific action (e.g., completing the steps of a task analysis targeted during or directly after instruction; 11%). Some studies incorporated multiple topographies of responding, such as teaching different skills that required both expressive and receptive identification, or receptive identification and incorporation of touchscreen features. Additionally, of the 9 studies evaluating touchscreen technology, 88% paired the technology with response prompting strategies or as methods of delivering prompting, including CTD (56%), forward chaining (11%), graduated guidance (GG, 11%), and video modeling (VM, 11%).

Other Technology Mediums

Skills and materials. The remaining 35% of studies identified in the search evaluated the use of laptops (7%), videos (21%), and e-text technology (7%) in delivering instruction to individuals in small group instructional settings. Studies evaluated these alternative mediums of high-tech instruction across individuals in preschool and elementary settings, as well as university and ABA centers, for instruction in literacy (e.g., reading comprehension) and daily living (e.g., play skills, daily classroom activities) skills. Several supplemental technology tools were used to complement the delivery of instruction. For all 3 studies that used video technology, the videos were displayed on a television via either an application on the television (e.g., YouTube) or VHS. The study that delivered instruction with a laptop used a researcher-designed PowerPoint presentation. The study evaluating etext technology used unique features such as electronic sticky notes, web-linked dictionaries, mind-mapping applications, and blogging sites to enhance reading comprehension instruction; however, the study did not specify on what type of device the tools were used. Of these studies, 80% utilized teacher-made

materials, including all video-based studies and a study evaluating PowerPoint presented on a laptop; one study used commercially-available applications along with etext technology.

Responding and prompting. Learners across studies were primarily required to respond by performing the steps of a task (e.g., completing the steps of a group game; 50%), but were also asked to respond expressively (17%) and receptively (17%). Half of the studies evaluating non-touchscreen technology combined instructional technology with response prompting procedures. Ozen et al. (2017) paired simultaneous prompting (SP) with PowerPoint displayed on a laptop to facilitate instruction of common objects and their location/function. Norman, Collins, and Schuster (2001) paired CTD and video modeling with a VHS video for instruction of self-help skills. Additionally, Kourassanis et al. (2015) incorporated video modeling for instruction of group childhood games.

Effects of Technology-Facilitated SGI

The studies employed a variety of single-case designs, including multiple probe designs across behaviors (64%) or participants (7%), multiple baseline designs across participants (14%) or behaviors (7%), and an adapted alternating treatment design (7%). These designs were used to evaluate the effectiveness of high-tech instructional tools on skills in the areas of literacy (reading comprehension, spelling, sight word identification, phonemes, letter sounds), leisure (gaming skills, group games), social skills (social engagement, communicative turn taking), and independent living skills (completion of classroom activities, self-help skills), as well as on-task behavior.

Across the 14 studies, 42 independent experiments were identified and evaluated through SCARF. Ninety-three percent of experiments met criteria as high quality (i.e., score above 2). Of those, most (77%) demonstrated consistent positive effects and 23% demonstrated evidence of

minimal or negative effect. Seven percent of studies were determined to be of low quality (i.e., score below 2), all of which met criteria for low quality evidence of positive effects. The SCARF protocol also allows researchers to analyze the quality and rigor of the designs' outcomes in terms of generalization and maintenance. For generalization, 52% of experiments indicated high quality evidence of positive effects for generalization, 43% indicated positive effects with moderate quality of measurement, 2.5% indicated high quality evidence of minimal or negative effects, and 2.5% indicated minimal or negative effects with moderate quality of measurement. Specifically, generalization was measured across materials, instructors, settings, and/or tasks in was measured across all studies, and 14 of the designs measured consistent positive effects shown via measurement in the context of the design. Finally, for maintenance, 36% of experiments indicated high quality evidence for positive effects, 14% indicated low quality evidence of positive effects, 7% indicated positive effects with moderate quality of measurement, 5% indicated high quality evidence of minimal or negative effects, and 38% indicated low quality evidence of minimal or negative effects. Specifically, 62% of the experiments evaluated some degree of maintenance, with 14% measuring maintenance at least one week but less than one month after completion of the study and 26% measuring maintenance one or more months after the completion of the study. Fifty-five percent of designs reported maintenance data that maintained outcomes similar to intervention levels; 38% did not measure or report maintenance.

Technology as Instructor

To evaluate the efficacy of using technology to fill the many roles of teachers, authors coded for the use of technology to provide 1) reinforcement for attending and/or responding, 2) error correction, 3) response prompting (e.g., using technology to incorporate CTD or SP into instruction), 4) attentional cues, and 5) to collect data on responding. Although each of the above

features may have been programmed by the researcher or instructor, they were delivered without the facilitation of the instructor during sessions. Of the 14 studies, 14% used technology to deliver reinforcement contingent on correct responding, all of which was used with touchscreen technology (iPad and IWB). Reinforcement was delivered in the form of animated characters, sounds, and descriptive verbal praise automatically delivered by the technology when the correct response was selected. Twenty-one percent of studies used technology to provide error correction by either providing the correct answer or preventing the participant from progressing if an incorrect answer was selected. Similarly, 21% of studies programmed technology to provide response prompting, including forward chaining, constant time delay, and simultaneous prompting in the form of video modeling. All other studies either relied on the instructor to deliver response prompting strategies or did not incorporate response prompting into instruction. Seven percent of studies used technology to provide an attentional cue in the form of a welcome message that required an attention response before starting the instructional session. No authors reported using the technology that delivered instruction to collect data on participant responding. Over half of the studies reviewed did not use the target technology to provide reinforcement, error correction, response prompting, attentional cues, or to collect data (57%). Of the 14 studies, only one study used the technology for instruction as well as multiple instructional features. In 2017, Chai and colleagues used an iPad tablet and a downloaded educational app created by the researchers to deliver instruction in phonemes, as well as to provide reinforcement, error correction, response prompting (CTD), and attentional cues.

Authors of many (67%) studies reported information on how many opportunities each student had to respond within a session, which ranged from a single opportunity to up to 21 opportunities a session. However, authors did not always report rates of responding or enough

information to calculate rates of responding, so these cannot be directly assessed. Additionally, none of the studies compared the OTRs during group instruction to OTRs in a 1:1 instructional setting. Over half of studies (60%) measured and found successful observational learning, but few (20%) incorporated and measured acquisition of instructional feedback.

Three of the 14 studies (21%) reported participant feedback concerning the technology used to deliver instruction. One study asked participants if they preferred the IWB technology to a comparison delivery method (flashcards); two participants favored the IWB technology, while the third provided varied responses. The remaining two studies did not ask participants about preference of instruction delivery but did receive feedback from participants concerning the technology used to deliver instruction. In both studies, participants reported "moderate to high satisfaction" with the technology and that they enjoyed using it "because they were good at it" (Jozwik et al., 2017; Chai et al. 2017).

Of the 14 studies examined, only one comparison study was included in the review. Mechling and colleagues compared instruction of sight words delivered via IWB technology and flash cards (Mechling et al. 2008). Researchers found little difference between the two methods of instruction delivery for both rate of acquisition and errors. However, participants had a higher rate of observational learning in the IWB condition, which the authors attributed to presenting the target words on a large screen for the entire group.

Discussion

The purpose of this review was to evaluate the incorporation of high-tech instructional tools into small group instruction. Specifically, researchers examined how that technology might contribute to instruction, what type of technology has been used in the context of small group instruction, and how students used the technology to respond. To explore these questions, studies

were reviewed which included instruction of a skill to students with special education services, with small group instructional arrangements that incorporated the use of high-tech instructional materials as the independent variable. Most experiments used rigorous designs and yielded high quality evidence, and 86.4% of designs yielded positive outcomes. Studies included in this review spanned settings (home, clinic, and school), age (preschool to high school transition programs), and populations (individuals with ASD, ID, LD, among others), all with results that indicated some degree of success in using high-tech tools to facilitate instruction in small group settings.

In 2012, Ledford reviewed literature on small group instruction and the use of response prompting procedures. In that review, the authors reported that 45 of 47 studies (96%) taught skills that required a vocal or signed response (Ledford et al. 2012). The current review found that a considerably smaller percentage of studies (47%) required an expressive response from learners. This may suggest that by incorporating technology and the unique features it provides (e.g., large screen, programmed consequences for each response, supplemental materials like PowerPoint and applications), learners who require a receptive response due to physical or developmental disabilities may be more easily incorporated into small group instruction (e.g., students do not vocally imitate a correct response may be more easily included in small groups when high tech instructional materials are used).

Data revealed that instructors did not generally take advantage of the unique features high-tech tools which might simplify a teacher's role during instruction, such as touchscreen technology and programs that can be programmed to provide error correction or prompting without the direct action of an instructor. For example, although 65% of studies evaluated technology that had a touchscreen component, only 29% of studies incorporated the touchscreen

technology into response topographies. Furthermore, only 20% of studies using an IWB used the interactive features; however, SMART Boards alone are installed in over 3 million classrooms worldwide and therefore are a widely accessible high-tech tool, despite their high price tag (SMART Technologies, 2018). This might indicate that trainings or tutorials may need to be implemented so that the features of this technology are used to maximize benefit while improving feasibility and reducing the need for human instructors to perform all components of each instructional trial (e.g., present stimulus, prompt responses, provide consequences, and collect data).

Future Research

As technology continues to evolve, instructors should consider ways to effectively incorporate instructional technology across instructional settings. Special and general education instructors alike use technology to deliver instruction. With opportunities for observational learning and limited instructional resources, educators should consider the use of technology for group instruction in special education. Small group instruction may result in leaner schedules of attention, reinforcement, and opportunities to respond when compared to 1:1 direct instruction due to a larger student-teacher ratio. One benefit of technology in small group instruction is that it has the potential to increase OTRs; instructors can easily create electronic instructional materials that can be downloaded, accessed, or replicated across instructional devices, allowing all students increased OTRs. Instructors may rely on response methods such as response cards to increase OTRs for group members (Berrong, Schuster, Morse, & Collins, 2007). While a good tactic for increasing OTRs, this method still relies on a single instructor to provide feedback and error correction to each student in the group. This specific area lacks empirical evaluation, and future research should compare and explore the use of instructional technology in small group

instruction in relation to OTRs, including the use of technology in delivering praise and corrective feedback.

Most studies included technology only as the medium for presenting stimuli. Future research should also consider exploring solely technology-mediated instruction. Many studies evaluated in this review utilized response-prompting strategies such as time delay or physical prompting procedures. However, many of these strategies were implemented by the instructor; future research should explore the efficiency and social validity of embedding these strategies within the instructional technology tool used to deliver the instruction. This avenue may also be expanded by exploring the use of instructional technology, specifically the use of computer-based technology such as tablets and IWB, in fulfilling other traditional roles of instructors. This may include corrective feedback, as mentioned above, as well as data collection and providing differentiated instruction for heterogeneous small group instruction.

Finally, future research should explore comparisons of high-tech instructional tools to more traditional, low-tech methods of instruction because this may increase the efficiency of instruction. Of the 14 studies evaluated, one study compared the use of high-tech tools to deliver instruction to another method of instruction (e.g., flash cards; Mechling et al. 2008). While effective, these high-tech tools may be costly to purchase, repair, or replace. Future researchers should focus on comparing high-tech instructional tools to other modes of instruction, like Mechling et al. 2008, to determine the efficacy of using these tools in instruction and justify up-front financial obligations. Research may focus on high-tech tools' efficacy and rate of instruction as compared to low-tech modes of instruction delivery, as well as other important features of instruction such as learner attention and on-task behavior, saving time and resources in preparing and presenting materials, and rate of instruction.

These studies have laid the groundwork for evaluating instructional technology in small group settings to facilitate the instruction of individuals who receive special education services. As new technological mediums continue to develop, research should continue to evaluate the effectiveness of these mediums in delivering and facilitating instruction, as well as how they relate to other variables of SGI, the overall efficiency of SGI, and the underlying processes of SGI.

Table 12.

Demographic information of participants from literature review

Study	Number of Participants	Age (in years)	Diagnosis / Eligibility	Skill
Ashmeade, 2016	3	13-15	ASD	Social Engagement
Campbell et al., 2009	3	5-6	[b]LD	Letter Sounds
Cattik et al., 2017	4	3-6	ASD	Online Gaming
Chai et al., 2017	3	4-5	SLD, DD	RI Phonemes
Jozwik et al., 2017	4	9-10	SLD, LD	Reading Comprehension
Kourassanis et al., 2015	2	5-6	PDD-NOS, ASD	Play Skills – Group Game
Mechling et al., 2007	3	19-20	MoID, DS, CP	Reading / Matching Sight Words
Mechling et al., 2008	3	19-21	MoID, DS, CP	Reading Sight Words
Norman et al., 2001	3	8-12	DS, MoID, [i]MiID, ASD, ADHD	Daily Living Skills
Ozen et al., 2012	3	9	ASD	Play Skills – Role Playing
Ozen et al., 2017	4	5-6	ID, DS, ASD	Daily Classroom Activities

Purrazella et al., 2013	3	18-20	ASD, MoID, CP	Spelling / Reading
Shepley et al., 2016	3	4-6	SDD, ASD	Sight Words
Therrien, 2016	5	4 – 5	ASD, ID, DD	Communicative Turn Taking

Note: ASD = autism spectrum disorder; LD = learning disability; SLD = speech and language delays; DD = developmental delays; PDD-NOS = pervasive developmental disorder not otherwise specified; MoID = moderate intellectual disability; DS – Down syndrome; CP = cerebral palsy; MiID = mild intellectual disability; SDD = Significant Developmental Delay; ID = intellectual disability.

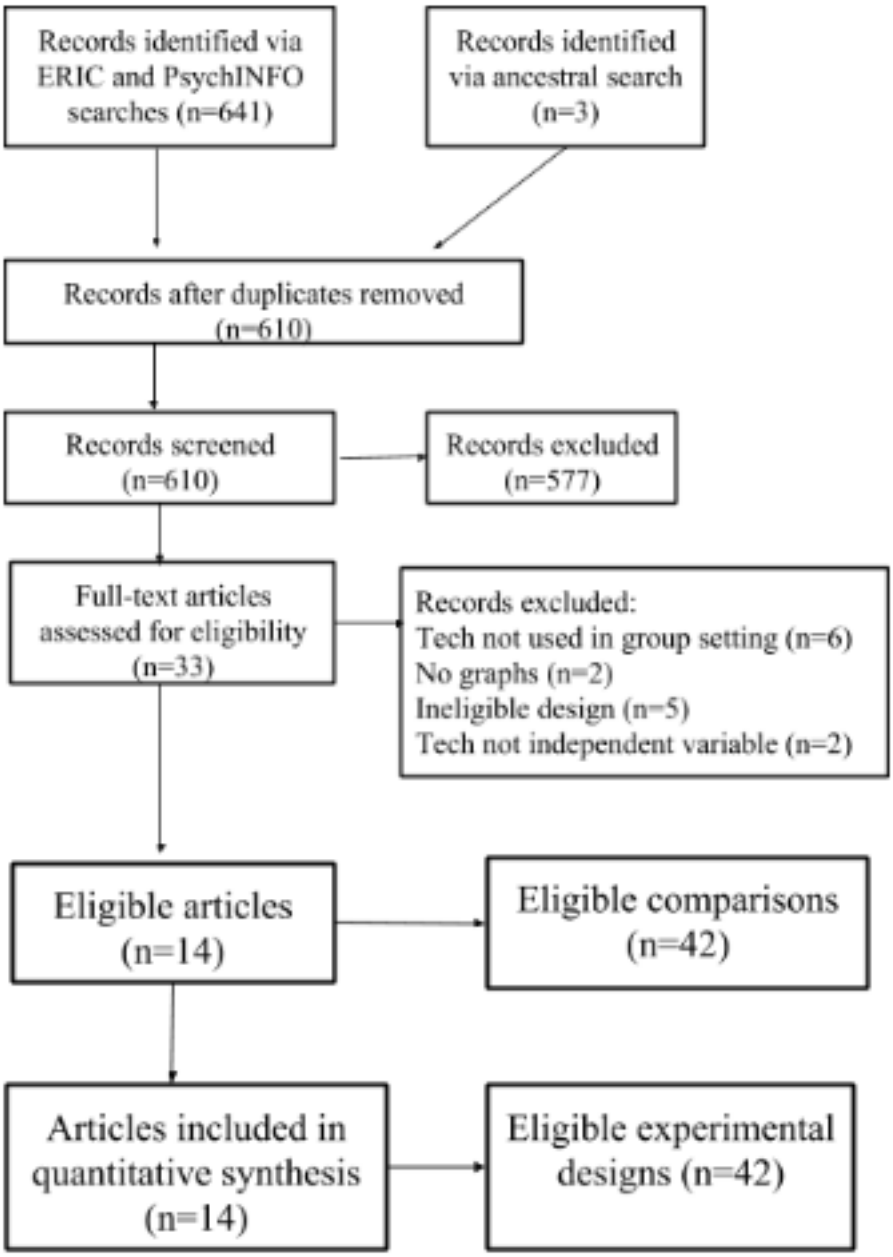

Figure 6. PRISMA diagram for study inclusion.