EFFECTS OF PROXIMITY FADING AND TASK BREAKS ON GROUP RESPONDING DURING DIRECT INSTRUCTION FOR STUDENTS WITH AUTISM

by

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ABSTRACT

JULIE LYN THOMPSON. Effects of proximity fading and task breaks on group responding during direct instruction for students with autism. (Under the direction of DR. CHARLES L. WOOD)

The purpose of this study was to investigate the effects of proximity fading and task breaks on responding during small group Direct Instruction in mathematics with students with ASD and the extent to which students demonstrate academic accuracy and generalization of responding. Using a multiple probe across participants design no functional relation was identified between group responding and proximity fading and task breaks. All students demonstrated improvement in mathematics performance from pre-test to posttest. Social validity indicated "strongly agree" for group responding instruction and "strongly disagree" for mathematics curriculum with regards to pacing of instruction and amount of language demands placed on participants. Future research on optimal group size, prerequisite skills required for effective group participation, and longer duration of DI mathematics instruction on skill acquisition is suggested.

DEDICATION

This is dedicated to my boys. Jeremy you were patient, supportive, hardworking, thoughtful and kind. You were and always will be just what I need. Lukas, you are my joyful, surprising, cuddly, and encouraging superhero. Don’t worry, I’ll never forget your “hug and kiss” before I go. I love you both dearly. Thank you for inspiring me to do my best. This is our dissertation. You contributed as much, if not more, to reach this achievement.

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CHAPTER 1: INTRODUCTION

Autism spectrum disorder (ASD) is characterized by "persistent impairment in reciprocal social communication and social interaction, and restricted, repetitive patterns of behavior, interests, or activities. These symptoms are present from early childhood and limit or impair everyday functioning" (American Psychological Association [APA], 2013, p. 53). Approximately 1 in 88 children are diagnosed with autism spectrum disorder (ASD; Centers for Disease Control and Prevention [CDC], 2012). ASD is five times more common in males and is identified within all cultures, races, and across all levels of socioeconomic status (CDC, 2012). The percentage of students with ASD ages 6-21 years receiving special education services in public schools increase annually (U.S. Department of Education [USDOE], 2012). From 2004 to 2011 there was a 146% increase in the number of school-age students receiving special education in public schools under the eligibility category of autism (USDOE, 2012, 2013). As the number of students with ASD increases, the pressure on schools to provide effective education with limited resources mounts (Loveland & Tunali-Kotoski, 2005). This rapid influx of students in an already overextended system has a direct impact on the student-teacher ratio and the selection of feasible but effective interventions (Boyd & Shaw, 2010). Educators are in need of research-based practices that are cost-effective and meet the needs of students with ASD (Arick, Krug, Fullerton, Loos, & Falco, 2005). This is a difficult task given the specialized interventions needed to address the learning needs of students with ASD (Simpson, McKee, Teeter, & Beytein, 2007). Individuals with ASD have the ability to hear and see others, yet they do not have access to the "social sense" that even individuals who are deaf-blind are able to perceive (Frith, 2008). It is this lack of "social sense," or social communication, that is the fundamental difference between autism and other disabilities. Four cognitive deficits identified as hallmarks of ASD that should be taken into consideration when developing and/or identifying interventions for students with ASD include joint attention, theory of mind, weak central coherence, and executive functioning (Rutter, 2011). These deficits impede performance in reading, writing, and mathematics (Whitby & Mancil, 2009). First, the skill of joint attention involves the use of eye gaze and/or gestures to draw another individual's attention to an item or event of interest and serves as a way to gain attention and share in an interesting item or event with another individual (Mundy, Sigman, & Kasari, 1990). An example of joint attention is when a child points to an airplane in the sky and the parent and child jointly watch the airplane fly out of sight. Joint attention may be elicited by either of the two individuals. Joint attention is an important foundational skill for language acquisition (Tomasello & Farrar, 1986). For example, as the child and the parent watch the airplane fly across the sky there are opportunities for the child to learn and practice vocabulary (e.g., the parent says, "Look at that plane flying up so high in the sky." The child says, "Up, up, up. High in the sky."). Problems with joint attention may limit a student in detecting information a teacher highlights as important during instruction.

Second, theory of mind refers to the ability to be able to make inferences regarding the thoughts of others in a given situation which enables one to predict the behavior of others (Baron-Cohen, Leslie, & Frith, 1985). This is a developmental skill that is generally sophisticated in most individuals by the age of four (Wellman, Cross, & Watson, 2001). In the seminal study on theory of mind, Baron-Cohen et al. (1985) tested theory of mind in individuals with autism using the "Sally - Anne" test. In this test a child is shown a doll, Ann, put an egg into a basket. Then Ann is put in another room. Then a different doll, Sally, takes the egg from the basket and places it in a box. The first doll, Ann, returns and the child is asked where Ann will look for the egg. A typically developing child would answer "in the basket where she left it." A child with autism generally answers, "in the box." The child with autism is unable to imagine the mind of the doll, that the first doll would not have known the egg was in the box. The child with autism knows the egg is in the box and cannot perceive that anyone else would think any different. This inability to predict the thoughts or perspective of others is the deficit of theory of mind. This is a critical social skill that enables individuals to infer the intentions or feelings of others and anticipate the behavior of others (Baron-Cohen et al., 1985; Durand, 2005; Haney, 2013). In academics, perspective taking is an important skill in areas such as writing a persuasive argument, understanding authors' intent, and completing complex mathematical word problems.

A third attribute of individuals with ASD is weak central coherence (Happé & Frith, 2006). Initially thought of as an inability to effectively integrate information and the tendency to over focus on details that may or may not be salient, it is now perceived as a cognitive bias towards details. Research has indicated that when individuals with ASD are explicitly required to focus globally on a task or concept, they are able to do so (Happé & Frith, 2006). For example, when shown a picture and asked to identify what it is an individual with ASD says, “couch” but when prompted by the instructor to tell what the “whole thing” is, the individual says, “living room.” In this example, the individual with ASD knew what a living room was, but had to be explicitly asked to identify the whole rather than a specific detail within the whole. Weak central coherence is paradoxical in that it can result in splinter skills or savant-like abilities in a certain area, but at the same time this hyper focus may result in impeding learning in other areas or focusing on salient information that would support learning other skills (Rutter, 2011). For example, an individual with ASD may be able to derive complex algorithms to support a novel mathematical theory, but have difficulty in engaging in a reciprocal conversation. It is also associated with acute sensory perceptions and difficulty with generalization.

The fourth area of deficit common in individuals with autism is executive functioning. Executive functioning is an overarching term that encompasses the skills needed to solve a problem and achieve a goal (Rajendran & Mitchell, 2007). Rajendran and Mitchell (2007) report planning, flexibility, and inhibiting previously reinforced responses have been consistently reported as executive functioning deficits in individuals with ASD (Rajendran & Mitchell, 2007). Problems with executive functioning can result in academic difficulties such as keeping track of assignments, organizing thoughts to develop a written product, or setting up an equation when solving word problems (Loveland & Tunali-Kotoski, 2005).

Addressing these core deficits may lead to increased skills in social interactions, behavior management, and acquisition, maintenance and generalization of academic knowledge (Carr & Durand, 1985). Mayton, Wheeler, Menendez, and Zhang (2010) emphasize identifying evidence-based practices as crucial for learners with ASD due to the rapidly increasing prevalence and the critical need to provide timely interventions and improve long-term outcomes for individuals with ASD. Two comprehensive literature reviews conducted by the National Autism Center (Howard, Ladew, & Pollack, 2009) and the National Professional Development Center for Autism (Wong et al., 2014) suggest that there are academic interventions for students with ASD, but not enough to establish them as "evidence-based".

There is a vast amount of research demonstrating that many interventions based on applied behavior analysis (ABA) are evidence-based with individuals with ASD (Arick et al., 2005; Smith, 2012). Researchers have used ABA to teach reading (e.g., Colman, Hurley, & Cihak, 2012; Jameson, Walker, Utley, & Maughn, 2012; Reichow & Wolery, 2011) and mathematics (e.g., Akmanoglu & Batu, 2004; Keintz, Miguel, Kao, & Finn, 2011; Levingston, Neef, & Cihon, 2009). The interventions used (e.g., time delay, prompting, task analysis, modeling, discrete trial training, discrimination training) and skills taught (e.g., division, coin identification, numeral identification, sight word recognition, letter sound identification, color identification, dictionary use) are too varied to meet the criteria established by Horner et al. (2005) as an evidenced-based intervention (minimum of five experimentally sound single-case studies, three different research groups across three different locations, and at least 20 participants) in reading, writing, or mathematics. Kasari and Smith (2013) highlight the disjointed nature of many research interventions explaining that the "curricular areas (the content of interventions) are often left vague. Because much more attention is given to the approach used to teach and intervention (the how) or to the dose of the intervention (e.g., hours per week) than what is taught, the core areas of impairment may not be addressed for children with ASD" (p. 257). ABA is not a curriculum (Arick et al., 2005) but a way of teaching socially significant skills through systematic instruction, analysis of data, and modifications to instruction based on the individual's performance (Baer, Wolf, & Risley, 1968; Cooper, Heron, & Heward, 2007). Arick et al. (2005) assert:

> "When used in combination with an appropriate curriculum sequence, these ABA instructional strategies can provide a powerful tool for enabling children with autism to meet important educational goals. Often, an important missing link in the field of special education is a comprehensive, research-based curriculum that uses the full range of instructional and behavioral techniques available to the educator" (p.1006).

There is, in fact, a set of curricula that encompass these instructional and behavioral techniques while providing an appropriate curriculum sequence. Direct Instruction (DI) curricula (e.g., Reading Mastery, Connecting Mathematics Concepts) utilize behavioral techniques including reinforcement, continuous data collection, sequential skill development, and task analytic instruction (Gersten, Carnine, & White, 1984). Gersten et al. (1984) explain that the main difference between DI and other behavioral interventions are the use of clear, consistent, and precise antecedent stimuli which include instructional materials that incorporate the transfer of stimulus control through stimulus and prompt fading; systematic error correction procedures; and teacher presentations scripts with explicit, predictable wording formats. DI has been shown effective in teaching language, reading, and mathematics to students with both high and low incidence disabilities (Kinder, Kubina, & Marchand-Martella, 2005).

Watkins (2008) described how the instructional components of DI including general case programming, track organization, scripted presentation, predictable formats, and pacing may be a good match for students with ASD given their difficulties with generalization, need for consistency and predictability, difficulty ascertaining and applying big ideas of instructional strategies, and attention difficulties (all symptoms of deficits in joint attention, central coherence, theory of mind, and executive functioning). Recent research on the use of DI curricula on skill acquisition of ASD has demonstrated promising results for teaching reading (Flores & Ganz, 2007; Flores & Ganz, 2009, Flores et al., 2013), communication (Ganz & Flores, 2009), and telling time (Thompson, Wood, Test, & Cease-Cook, 2012). To date, this small research base is not extensive enough to establish DI as an evidenced-base practice; however, the results are promising.

As research in this area continues, it is important to consider the features which will make the implementation of DI feasible and efficient for use in school settings. Kasari and Smith (2013) discuss barriers of research-to-practice in school settings with students with ASD and provide suggestions for overcoming these barriers. The authors note that priorities of researchers who seek to address the characteristics of ASD may be at odds with teachers whose priority is to teach academics (Kasari & Smith, 2013). In addition, they emphasize the importance of context when conducting research and explain that most research is not carried out in the natural setting which can result in researchers overlooking possible roadblocks that may need to be overcome for successful intervention in schools. Further they suggest that research be conducted in the natural school setting to support alignment between research and the school environment. Whole group instruction is the most common mode of teaching in classrooms and researchers should consider ways to support this type of instruction when conducting research. Finally, Kasari and Smith indicate participants selected for research studies who are typically less diverse, more verbal, and higher functioning may not be representative of the majority of students with ASD. Many students with ASD attend public schools, represent greater diversity, are lower functioning, less verbal, and may not be native English speakers.

Unfortunately, the research base investigating the effects of DI on skill acquisition of students with autism is indicative of several of these barriers. Only one of the studies reported the cultural diversity of the participants (Thompson et al., 2012) and only two of the studies included students with ASD who demonstrated an IQ of moderate intellectual disability (Flores et al., 2013; Thompson et al., 2012). Of the five studies, three were implemented in a small private school for children with ASD and/or intellectual disabilities (Flores & Ganz, 2007, 2009; Ganz & Flores, 2009) and one was implemented in a specialized summer camp (Flores et al., 2013). Only the Thompson et al. (2012) study was implemented in a public school setting; however, instruction was provided in a tutor room using one-to-one instruction which does not reflect realistic instruction in public schools. Flores and Ganz (2007, 2009) and Ganz and Flores (2007) indicated that they taught students in groups but did not indicate the level of accuracy of group responses. Further, their studies also included students with disabilities other than ASD who typically do not have difficulty with group responding and/or participation. This may have influenced the students in the studies with ASD by providing a model for group responding behaviors. Flores et al. (2013) specified that students were taught in groups ranging from two to four students and indicated that the instructor followed procedures to ensure the students demonstrated group responses. The authors did not report the level of accuracy of group responses. None of the studies denoted whether the students selected were typically successful during group instruction or if appropriate behavior during group instruction was a criteria for inclusion in the studies. This is an important clarification for two reasons: (a) many students with ASD may respond successfully during one-on-one instruction, but demonstrate significant difficulty attending and participating during small group instruction, and (b) due to increasing numbers of students with ASD resulting in increasing class sizes, it is important to identify ways to maximize the efficiency of instruction by teaching students in groups.

Group instruction employing choral responding has been investigated with students with ASD using discrete trial training instruction (e.g., Kamps, Dugan, Leonard, & Dauost, 1994; Leaf et al., 2013) and results indicated that students demonstrated increased skills, group responding, and academic engagement; however, little information has been provided on the techniques used to ensure students were simultaneously responding and procedures for teaching group responses. Further, all but one study (Kamps et al., 1994) using DI or discrete trial training during group instruction, employed researchers with advanced behavior analytic skills (e.g., board certified behavior analysts) as implementers. More research is needed on the explicit strategies used to increase accurate group responding behavior with students with ASD implemented by adults or peers from the school setting.

Kasari and Smith (2013) suggest that one way to increase fidelity of implementation of interventions is to develop a manual of the key components of the intervention. Engelmann (2006) developed a manual for teaching skills to students identified as “low performers” suggesting criteria for inclusion in group instruction such as following simple commands and accurately responding to yes/no questions, providing high structured instructional arrangements, incorporating frequent breaks from task demands, and using proximity control. Research on providing noncontingent escape (i.e., task breaks provided on time intervals) to students with ASD has resulted in increased on-task behavior and decreased problem behavior (e.g., Geiger, Carr, & LebBlanc, 2010) and research on proximity fading has shown promising results on increasing academic engagement of students with ASD (e.g., Conroy, Asmus, Ladwig, Sellers, & Valcante, 2004).

In summary, students with ASD need specialized interventions that are feasible and durable for school settings. Cognitive deficits resulting from ASD may impact ability to detect salient academic information, infer perspective or intent of instructors or curricula, generalize skills to novel situations, organize and complete academic goals. ABA interventions have resulted in improved functioning of individuals with ASD but has had limited impact on acquisition of academic skills. Academics are taught using curriculum in schools and feasibility and durability of implementation may be improved by identifying curricula which may be effective for teaching academics to students with ASD. DI may be an effective curricula for teaching students with ASD due to the explicit features of the DI programs which appear to match the learner characteristics of individuals with ASD. DI curricula are designed to be taught during group instruction and rely heavily on unison responding; yet, individuals with ASD are primarily taught on-on-one or sequentially within groups. A few studies have used unison responding to teach student with ASD; however, explicit information on how unison responding was elicited and whether selected participants already demonstrated successful participation during group instruction has not been delineated. Research is needed to identify specific strategies to support learners with ASD who may be successful in learning in a one-on-one setting but demonstrate problem behaviors and/or limited participation during small group instruction to access small group DI instruction.

Purpose of Study and Research Questions

The purpose of this study was to investigate the effects of proximity fading and task breaks on responding during small group Direct Instruction in mathematics with students with ASD and the extent to which students demonstrate academic accuracy and generalization of responding. Specifically, the following research questions were addressed in this study:

1. What are the effects of proximity fading and task breaks on the number of responses during small group Direct Instruction in mathematics for students with autism?
2. To what extent do students demonstrate academic response accuracy when responding during small group Direct Instruction in mathematics?
3. What are the effects of Direct Instruction on mathematics skills of students with autism?
4. To what extent do students generalize responding during small group Direct Instruction in language?
5. To what extent do students generalize academic response accuracy when responding during small group Direct Instruction in language?

6. What are teachers' perceptions of the acceptability and feasibility of the intervention?

Dependent Variables

Responding during small group instruction. Responding during small group instruction includes student responses such as choral responding, touching, pointing, crossing out, or writing that occurs within 1 s of the teacher's signal. The student's response does not have to be academically accurate to be counted as a correct response. Responses will be counted correct if the student responds within 1s of the teacher's signal. For example if the teacher says, "10. What's the next number?" and signals (e.g., says, "everybody"), the student will respond within 1s following the signal. If the response is an incorrect answer but occurs within a 1s latency it will still be counted as a correct response.

Academic response. An academic response is a response elicited by an instructor's signal that demonstrates a mathematic skill (during CMC instruction) or language skill (during Language for Learning [LfL] instruction). Secondary data will be collected on academic accuracy of participants' group responding. For example, if the teacher says, "10. What's the next number?" and the student responds "11" within 1s the response will be counted as a correct academic response.

Mathematics skills. Mathematics skills will be measured proximally using the CMC-A cumulative tests (Engelmann & Engelmann, 2012) and distally using Assesing Student Proficiency in Early Number Sense (ASPENS; mathematics subtests "numeral identification," "magnitude comparison," and "missing number" (Cambium Learning

Group, 2011). Both assessments will be administered to each student prior to baseline and following the final phase of group responding instruction.

Significance of Study

This study has potential to support academic instruction of students with ASD in several ways. First, it may provide a model for explicitly teaching group responding during direct instruction. Second, it may increase efficiency of academic instruction by enabling the teacher to spend more time teaching a greater number of students and potentially covering more academic content throughout the school day. Further, the efficiency of instruction may also increase the opportunity for teachers to provide social skills and functional skills instruction. Last, the increased opportunity for active engagement will likely improve academic outcomes of students with ASD.

Delimitations

This study will evaluate the effects of proximity fading and task breaks on group responding during Direct Instruction on students with ASD. Possible delimitations include the use of the researcher as implementer, participant inclusion addressing only one subset of "spectrum" of students with ASD, and cost of DI curricula. Further research will be needed investigating teacher implementation of the intervention to examine the feasibility and fidelity of implementation by a natural participant of the environment. Given the limited number of participants, additional research will be needed to establish whether this intervention is evidenced-based. Finally, given the limited resources of schools the cost of DI curricula may also limit implementation of the intervention.

Definitions

Applied behavior analysis. “A scientific approach for discovering environmental variables that reliably influence socially significant behavior and for developing a technology of behavior change that takes practical advantage of those discoveries” (Cooper, Heron, & Heward, 2007, p. 3).

Autism spectrum disorder. A disorder characterized by “persistent impairment in reciprocal social communication and social interaction, and restricted, repetitive patterns of behavior, interests, or activities. These symptoms are present from early childhood and limit or impair everyday functioning” (APA, 2013, p. 53).

Academic response. A response elicited by an instructor’s signal that demonstrates a mathematic skill (during CMC instruction) or language skill (during Language for Learning [LfL] instruction).

Comorbidity. Comorbidity occurs when an individual is diagnosed with two or more conditions (e.g., ASD and ADHD, ASD and intellectual disability; Heward, 2013).

Direct Instruction (DI). “Direct Instruction (in capitalized form) refers to the specific systematic approach to curriculum analysis, instructional design, and teaching principles developed by Siegfried Engelmann and Wesley Becker” (Watkins, Slocum, & Spencer, 2011; p. 298). It is scripted and sequences skills using a tracked approach to provide practice of multiple skills across several lessons while systematically increasing the complexity of the skills over time. DI emphasizes quick pacing and use of formats to provide predictability of instruction and signals to promote group responding (Watkins & Slocum, 2004)

Evidence-based practice. An intervention is considered evidence-based when an experimental effect is identified by a minimum of five experimentally sound single-case studies, three different research groups across three different locations, and with at least 20 participants (Horner et al., 2005) or when investigated by a minimum of four acceptable quality, or two high quality group design studies with a weighted effect size significantly greater than zero (Gersten et al., 2005).

Executive function. Executive functioning is an overarching term that encompasses the skills needed to solve a problem and achieve a goal (Rajendran & Mitchell, 2007). Executive functioning skills include planning, initiating, decision-making, sustaining, shifting, and controlling impulses (Rajendran & Mitchell, 2007).

Joint attention. Joint attention involves the use of eye gaze and/or gestures to draw another individual's attention to an item or event of interest and serves as a way to gain attention and share in an interesting item or event with another individual (Mundy, Sigman, & Kasari, 1990).

Noncontingent task breaks**.** A break from task demands provided on a fixed interval schedule that is not dependent on specific student behavior (Geiger, Carr, LeBlanc**,** 2010; Volmer, Marcus, Ringdahl, 1995).

Proximity fading. Systematic reduction of distance between the instructor and the student (Harper, Iwata, & Camp, 2013).

Responding during small group instruction. Responding during small group instruction includes student responses such as choral responding, touching, pointing, crossing out, or writing that occurs within 1 s of the teacher's signal. The student's response does not have to be academically accurate to be counted as a correct response.

Task demands. Instructor presented requests (Pace, Ivancic, & Jefferson, 1994).

Theory of mind. “Being able to infer the full range of mental states (beliefs, desires, intentions, imagination, emotions, etc.) that cause action. In brief, to be able to reflect on the contents of one’s own and other’s minds” (Baron-Cohen, 2000, p. 3).

Weak central coherence. A tendency to focus on details instead of integrating information in context. In other words, demonstrating strong local processing and weak global processing (Happé & Frith, 2006).

CHAPTER 2: REVIEW OF THE LITERATURE

This chapter will review selected research on the following topics relevant to the purpose of this study: autism spectrum disorder (ASD) characteristics, academic interventions for students with ASD, Direct Instruction (DI), group instruction, and Applied Behavior Analysis (ABA). Each topic will be summarized and the direct relation to the purpose of the current study will be highlighted.

ASD Characteristics

This section will review the definition of ASD and provide detailed descriptions of the characteristics of the disorder. Next, discussions of literature related to the theoretical perspectives of cognitive processing of individuals with ASD will be included. Finally, research related to educational implications of ASD characteristics will be discussed.

Autism spectrum disorder (ASD) is characterized by "persistent impairment in reciprocal social communication and social interaction, and restricted, repetitive patterns of behavior, interests, or activities. These symptoms are present from early childhood and limit or impair everyday functioning" (American Psychological Association [APA], 2013, p. 53). Social communication deficits include impairments in use of pragmatic language, impairments in understanding nonverbal cues, literal understanding of words, delayed language acquisition or limited to no functional language acquisition (APA, 2013). Social interaction deficits include difficulty with social reciprocity (e.g., taking turns in conversation), limited interest in social interaction, and difficulty in initiating and maintaining relationships (APA, 2013). Restricted behaviors include intense obsessive focus on interests, extremely high or low sensitivity to sensory input (e.g., pain, noise, temperature), and compulsive or ritualistic behaviors. Repetitive behaviors include rigid insistence on sameness, repetitive use of objects or physical movement, and disproportionate distress to changes in environment or routines (APA, 2013). Other characteristics associated with ASD include gross and fine motor delays, self-injurious behavior, restricted eating patterns, and problems with sleep. Conditions most commonly identified as comorbid with ASD include intellectual disability, ADHD, epilepsy, anxiety, and depression (APA, 2013).

Turner, Stone, Pozdol, and Coonrod (2006) conducted a longitudinal study of 25 children with ASD diagnosed at age 2 to determine predictors of diagnostic, language, cognitive, and academic outcomes 7 years following initial diagnosis. Results indicated children who were diagnosed earlier demonstrated significantly better outcomes than individuals diagnosed later. Diagnostic category within ASD (i.e., ASD, Asperger Syndrome, Pervasive Developmental Disorder – Not Otherwise Specified [PDD-NOS]) remained stable from age 2 to age 9. However, cognitive profiles increased significantly. A test of early language was predictive of whether or not 9 year-olds were able to use conversational language; but total number of expressive vocabulary was not predictive of language outcomes at age 9. Quantity of speech language therapy between the ages of 2 and 3 was predictive of improved outcomes; however, quantity of educational therapy was not predictive of improved outcomes. The authors suggest this may be due to provision of speech therapy in one-on-one situations compared to educational therapy typically provided during group instruction. The authors suggest that this information contributes to theory that early intervention is predictive of individual outcomes. Eighty-eight percent of children with ASD at age 2 met criteria for ASD at age 9. This indicates that diagnosis at age 2 is generally accurate; it also indicates that while cognitive and language profiles may improve, ASD characteristics remain stable throughout development. At age nine, 28% of individuals with ASD demonstrated IQs less than 70 (as opposed to 84% at age 2) and 68% of individuals with ASD had either limited verbal skills (not conversational) or were considered nonverbal. The study did not use any measures of social interaction.

Howlin (2005) reviewed 15 longitudinal studies that reported social and independence outcomes of adults with ASD. The author summarized outcomes as “good,” “fair,” or “poor,” and assigned percentages of participants to each category for all studies reviewed. Participants identified as having “good” outcomes were living independently, with a job and one or more friends. Participants with “fair” outcomes required some supports for employment or daily living but had some level of independence. Participants with “poor” outcomes were unemployed, had limited social interaction, and resided either with parents or in a residential facility with high levels of supports. On average, of the 930 of participants in the 15 studies, 16% of individuals with ASD demonstrated “good” outcomes as adults, 28% demonstrated “fair” outcomes, and 54% demonstrated “poor” outcomes. Howlin (2005) indicated that increased access to least restrictive educational placements and number of years of schooling, as well as demonstrating an IQ of greater than or equal to 70 are predictive of more positive outcomes. Conversely, individuals with an IQ of 50 or less who do not demonstrate functional speech by age 5 generally have much poorer outcomes. Notably, severity of ASD characteristics did not demonstrate a correlation with outcomes (Howlin, 2005).

Theoretical perspectives. Several cognitive theories have been developed to explain the core features of ASD (Reinvall, Voutilainen, Kujala, & Korkman, 2013). Recent empirical research has added validity to these theories (Rajendran & Mitchell, 2007; Rutter, 2011). These theories identify deficits in joint attention, theory of mind, central coherence, and executive functioning. Theories of joint attention and theory of mind are associated with deficits related to social language and interactions, theory of executive functioning is used to explain characteristics related to restricted and repetitive interests, and central coherence accounts for characteristics associated with both restricted interests and social impairments (Rajendran & Mitchell, 2007; Reinval et al., 2013). Each will be discussed in detail in the subsequent sections.

Joint attention. Joint attention is attention of two individuals towards a shared item or activity of interest. Joint attention usually occurs when one individual points, gestures, or otherwise indicates to the other individual the presence of the item or activity. This provides an opportunity for social interaction and vocabulary acquisition (Tomasello & Farrar, 1986). Tomasello and Farrar (1986) conducted two studies to examine the relationship between joint attention and language acquisition of typically developing toddlers. In the first study, using a longitudinal correlational design, the authors observed the number of child utterances, child words per minute, child object labels per minute, child conversational turns, mother comments, mother questions, and mother directives during a 15 minute play period with novel toys when the child was 15 months old and again at 21 months old. Each measure was noted as occurring during a joint attention episode or when the mother-child dyad was not engaged in joint attention and measures were analyzed using a 2 x 2 repeated measures ANOVA. At age 15 months there were no statistically significant differences between language measures during joint attention episodes versus non-joint attention episodes; however mean language measures were higher during joint attention episodes. At age 21 months there were statistically significant differences between joint attention episodes versus non joint attention episodes with means higher during joint attention episodes for child utterances, child words per minute, child object labels per minute, child conversational turns, mother comments, and mother questions. Also, as might be expected, there were statistically significant differences for all child language measures between age 15 months and 21 months. The second study used a quasi-experimental pre-test post-test investigation comparing frequency of spontaneous production, frequency of elicited production, and percent comprehension of novel object labels between object labels that were taught either during a joint attention episode or by redirecting the child to the object during a non-joint attention episode. Results indicated a statistically significant difference between percent comprehension of objects with a greater mean demonstrated with objects that were taught during joint attention episodes. The authors indicated that joint attention provides opportunities for extended early linguistic interactions and is central to increasing language development (Tomasello & Farrar, 1986).

Given the importance for joint attention for language development, Mundy, Sigman, and Kasari (1990) conducted a longitudinal study to determine the relationship between joint attention skills and language development of 15 children with ASD and two control samples. One control sample consisted of 15 individuals identified as mentally retarded who were matched to the individuals with ASD based on mental age. The second control sample consisted of 15 individuals identified as mentally retarded who were matched to the individuals with ASD based on language performance. Pre-test post-test measures were obtained with a 13-month break between tests. Each participant was observed during a 25 minute session with an experimenter in a room with high interest toys and activities, and frequency of joint attention, social initiation, and requests were measured. In addition, each participant was given a language assessment. Mean scores for initial and follow-up measures were reported. Results indicated a statistically significant difference between individuals with ASD and both control groups in joint attention, with individuals with ASD demonstrating lower frequency of joint attention episodes. In addition, there was a significant correlation between joint attention and language development for individuals with ASD. The authors indicated that these results support findings from previous studies underscoring the importance of joint attention for language development (Mundy, Sigman, & Kasari, 1990).

Whalen and Schriebman (2003) investigated the effects of joint attention training on joint attention responding and joint attention initiating with 5 four-year-olds with ASD. The authors recorded joint attention skills of typically developing children and used mean scores for this group as a mastery criterion. Using a multiple baseline across participants design, results indicated a functional relation between joint attention training and joint attention responding and initiating for four of the five participants. The fifth participant was identified as performing significantly lower on language and social interaction skills and was included to determine how individuals with ASD with more significant delays might respond to joint attention training. However, after 10 weeks of joint attention training with little improvement in joint attention responding, the participant was excluded from the remainder of the study. The four remaining participants demonstrated a higher increase in joint attention responding than joint attention initiating. None of the participants achieved mastery criterion as gauged by performance of typically developing peers. Two of the four participants who completed the study, maintained joint attention initiating and responding at a three-week follow up assessment following cessation of intervention. A limitation identified by the authors was that the study was implemented by clinicians in a clinical setting. They suggested future research investigate the effects of teacher implementation of joint attention training on students with ASD joint attention skills.

Wong (2013) investigated the effects of teacher implemented joint attention training on the joint attention skills of 33 preschool students with ASD ages 3 to 6-years-old. A randomized wait-list control design was used to assign teachers in 14 classrooms to intervention or control groups. During intervention, teachers were trained one hour per week for a total of eight weeks on strategies for supporting joint attention and symbolic play. Using hierarchical linear modeling, measures of joint attention, joint engagement, and play were assessed three times (prior to intervention, midway, and following intervention) over an eight week period. Assessments included classroom observation, an individual social communication assessment for each child participant, and an individual structured play assessment for each child participant. Results indicated a statistically significant difference in the amount of time children with ASD and teachers were engaged in joint attention between intervention and control groups. In addition, a statistically significant difference was demonstrated in joint attention responses, joint attention initiations, and symbolic play from the initial assessment to the final assessment in the children with ASD. Teachers indicated the intervention was feasible and effective (Wong, 2013).

Holth (2011) reviewed the literature on joint attention and asserted that while joint attention has been primarily described in mentalistic terms, it is important to behaviorally define joint attention in order to develop effective interventions to increase the skill of joint attention. Describing joint attention as a pivotal skill, Holth indicated that by increasing this skill individuals with ASD may have increased opportunities for improving social skills and language development and comprehension. He described a joint attention episode as the presence of an object or event acting as a motivating operation, which evokes the behavior of initiating joint attention from another individual (e.g., gazing towards the other individual, calling out, pointing), this other individual has a history of providing reinforcement for the joint attention initiation (e.g., smile, praise, affection; Holth, 2011). Holth indicated that for individuals with ASD it is necessary to establish other individuals' social responses as reinforcing in order to increase joint attention episodes.

One study has successfully demonstrated establishing others as reinforcing. Taylor and Hoch (2008) investigated the use of social contingencies alone (i.e., social interactions as reinforcers instead of using tangible items as reinforcers) to elicit joint attention behavior. The authors operationalized joint attention behaviors as shifting gaze between the individual and object of interest, vocally responding to joint attention requests, and vocally initiating joint attention with another individual. This study differs from the previous interventions reviewed in that two of the participants with ASD were elementary school-aged (5-years-old and 8-years-old) whereas the other studies included only participants preschool-aged or younger. Using a multiple baseline across participants design results indicated a functional relation between the intervention (time delay, prompting, and verbal and physical social reinforcement [e.g., praise plus tickles or high fives]) and joint attention skills. One student, the 8-year-old, required a checklist for initiating joint attention in order to increase this skill to an acceptable level. The authors indicated that this demonstrates the importance of social reinforcers for eliciting and maintaining joint attention.

Theory of mind. Theory of mind is defined as the ability to infer the perspective of another individual (Baron-Cohen et al.,1985). Baron-Cohen et al. (1985) first investigated whether individuals with ASD had deficits with theory of mind by comparing results on a theory of mind assessment of 20 individuals with ASD to 14 individuals with Down Syndrome, and 27 typically developing children. The assessment determined if a participant could recognize that others might have different perspectives. In the case of the assessment, participants knew where a hidden object was located because the instructor showed them, but the doll used in the assessment was shown the object placed in a different location. Participants were asked to identify where the doll would look for the object. Eight-five percent of the typically developing participants and 86% of the participants with Down syndrome correctly indicated that the doll would look for the object in the location where the doll had last seen the object placed. Whereas only 20% of the participants with ASD were correct (Baron-Cohen et al., 1985). The authors suggest that this deficit cannot be attributed to intellectual disability based on the results of the participants with Down Syndrome and suggest that this deficit is uniquely linked to individuals with ASD. Furthermore, the authors indicate this deficit may increase understanding of the social impairments of individuals with ASD by demonstrating their difficulty in understanding the perspective of others.

Frith, Happé, and Siddons (1994) conducted a follow-up study to determine if differences exist between individuals with ASD who pass theory of mind tests and those who fail. In addition they compared these results with typically developing individuals and those with learning disabilities. The authors were particularly interesting in determining whether passing theory of mind tasks translated to real world applications of theory of mind (e.g., understanding others intended meaning). Results indicated that individuals with ASD who passed theory of mind tasks had much greater verbal ability than those who failed. Of those who passed clinical theory of mind tasks, only 24% demonstrated the ability to apply theory of mind skills in real world settings according to social adaptations scores on a standardized behavior scale. When compared to individuals who were typically developing or had learning disabilities, individuals with ASD performed significantly lower on theory of mind clinical tasks and social skills demonstrating real world theory of mind applications.

Paynter and Peterson (2013) investigated the effects of thought bubble training on the theory of mind of children with ASD ages 6 to 12-years-old. Using a quasi-experimental design, 17 children were placed in the training group; and seven, matched by age, intellectual ability, and severity of ASD were placed in the control group. Thought bubble training involved using character drawings or 3D dolls with cartoon bubble shapes placed above the heads with writing inside representing the private thoughts of the characters. Using pre-test post-test measures, results indicated a significant difference between the training and control groups with the training group performing higher on theory of mind tasks. In addition, maintenance measures were obtained three weeks following intervention and the significant difference remained. Limitations to the study included the implementation in a clinical setting and teaching only a change in location task similar to the task previously described in Chapter 1. The authors indicate that the use of the thought bubble is a promising approach to improving individuals' with ASD understanding of the intentions of others.

Weak central coherence. Frith and Happé (1994) explain that while Theory of Mind is useful, it does not wholly account for all the characteristics associated with ASD. Specifically, Theory of Mind does not address restricted interests, behavioral rigidity, splinter skills, and strong rote memory skills. The authors suggest that ASD might be better explained by the theory of weak central coherence. Weak central coherence involves hyper- focus on details in lieu of attending to the whole of an object or concept (Happé & Frith, 2006). Happé and Frith (2006) explain that this detailed focus can lead to problems with generalization; the inability to integrate information would mean that specific details, if minutely different from other details, would not be seen as similar. Therefore, skills that might be applied to one situation would not be recognized as applicable to a novel but similar situation.

Happé and Frith (2006) reviewed 58 correlational studies comparing central coherence skills of individuals with ASD to typically developing and/or individuals with other disabilities such as intellectual disabilities or specific learning disabilities. Findings indicated consistent detailed processing in auditory skills (e.g., absolute pitch) and visual skills (e.g., discriminating between highly confusable patterns). Findings were less consistent regarding global processing with some studies identifying deficits and others little to no deficits. The review of research indicated that individuals with ASD are able to process globally if explicitly told to do so which, according to the authors, demonstrates a bias towards detailed processing rather than an inability to globally process (Happé & Frith, 2006). Happé and Frith suggest that educational approaches should be developed to address weak central coherence.

Executive functioning. Executive functioning involves the ability to achieve goals and solve problems by planning, initiating, decision-making, sustaining, shifting, and controlling impulses (Ozonoff, South, & Provencal, 2005; Rajendran & Mitchell, 2007). Geurts, Verté, Oosterlaan, Roeyers, and Sergeant (2004) compared executive functioning of individuals with ASD to individuals with ADHD and a control group of typically developing individuals. Forty-one children with high-functioning ASD ages 6 to 13-years-old were assessed on inhibition, working memory, planning, flexibility, fluency, response execution, short-term memory, and categorization. Individuals with ASD demonstrated greater deficits in executive functioning than individuals with ADHD. Significant differences were found between individuals with ASD and typically developing individuals in inhibition, planning, flexibility, fluency, response execution, and short-term memory. Similar results have been found in additional studies (e.g., Pooragha, Kafi, & Sotodeh, 2013; Semrud-Clikeman, Fine, & Bledsoe, 2013).

Ozonoff, South, and Provencal (2005) note that very little experimental research has been conducted to identify interventions to improve executive functioning skills. The authors indicated that some accommodative approaches have been used such as visual supports and schedules to address components of executive functioning. The authors suggested additional investigation of ameliorative interventions to address executive functioning deficits (Ozonoff, South, & Provencal, 2005).

Educational implications. Given that the primary features of ASD are social communication deficits and restrictive and/or repetitive behaviors it is not surprising that evidence-based practices derived from a comprehensive review of the literature primarily address behavioral and social interventions (Howard et al., 2009; Wong et al., 2013). Yet, the importance of academic interventions should not be diminished and are of crucial importance in equipping individuals with ASD to achieve their potential and prepare for their future. The characteristics and theoretical perspectives described above provide insight into areas of strength and deficits that must be taken into consideration when identifying and developing academic interventions. Additional research has been conducted to ascertain academic achievement profiles of individuals with ASD and will be discussed below. Next, a brief examination of current identified evidence-based practices followed by a discussion of service delivery for students with ASD in educational settings will be provided.

Academic achievement and ASD. Chiang and Lin (2007) conducted a review of studies investigating the cognitive ability and academic achievement of students with ASD with an emphasis on mathematical ability. Participants in the 17 studies reviewed had IQs between 40-146 and ages ranging from 4 to 51-years-old. The authors reviewed results to determine whether individuals with ASD have mathematical deficits, a relative weakness in mathematics, and/or mathematical giftedness. Findings indicated individuals with ASD have average mathematical skills overall, a significant difference in mathematical skills and mathematical achievement was identified, and some participants with ASD were identified as demonstrating mathematical giftedness. Based upon these results, authors suggest that individuals with ASD be provided with age-appropriate mathematical curricula.

These findings were substantiated by Whitby and Mancil (2009). The authors reviewed literature on academic achievement of individuals with high functioning ASD and Asperger syndrome to determine if an overall achievement profile became apparent. The authors identified six studies involving a total of 473 participants age 3 to17-years-old. Results indicated participants demonstrated average basic reading, decoding, and mathematical skills. Participants displayed deficits in comprehension, written expression, and complex problem-solving skills.

An additional review on the achievement of individuals with ASD included students across the spectrum of abilities (i.e., not limited to students with high functioning ASD or Asperger syndrome). Estes, Rivera, Bryan, Cali, and Dawson (2011) investigated the relationship between intellectual ability and academic achievement in 30 children with ASD in a quasi-experimental longitudinal correlation study. Participants were assessed at ages 3, 6, and 9. Researchers were interested in whether a discrepancy between predicted academic achievement based on IQ and observed academic achievement would be demonstrated. Results indicated a significant difference between predicted and observed academic achievement with 60% of participants demonstrating significantly lower achievement in at least one academic domain (i.e., word reading, spelling, basic number skills). Interestingly, 60% of participants also demonstrated significantly higher achievement in at least one domain. Authors indicated that strengths in rote memory may have contributed to higher achievement, while executive functioning deficits may have contributed to lower achievement. It is possible that weak central coherence contributed to the inconsistences of academic performance.

Further, May, Rinehart, Wilding, and Cornish (2013) attempted to parse out a possible cause of decreased academic achievement by investigating the role of attention on the academic achievement of individuals with ASD by comparing hyperactivity symptoms, ability to switch attention, and/or maintain attention with academic achievement. Sixty-four participants ages 7 to 12-years-old with IQs at or above 70 were assessed. Overall, no significant differences were demonstrated between attention and academic achievement in reading or mathematics; with the exception of a significant negative correlation between individuals with ASD who demonstrated deficits in attentional switching and mathematics achievement.

Current evidence-based practices. Two research groups have conducted extensive, systematic reviews of ASD intervention research to identify evidence-based practices (Howard et al., 2009; Wong et al., 2014). Studies were included if they met quality indicators demonstrating scientific merit and interventions were identified as evidence-based practices if they met criteria of at least 2-3 peer-reviewed group studies, or 4-5 peer-reviewed single-case design studies, or a combination of both. Howard et al. (2009) identified 11 established evidence-based practices: antecedent package, behavioral package, story-based intervention package, modeling, naturalistic teaching strategies, peer training package, pivotal response treatment, schedules, self-management, comprehensive behavioral treatment for young children, and joint attention intervention. Wong et al. (2014) identified 27 evidence-based practices: antecedent-based intervention, cognitive behavioral intervention, differential reinforcement, discrete trial teaching, exercise, extinction, functional behavior assessment, functional communication training, modeling, naturalistic intervention, parent-implemented intervention, peer-mediated instruction and intervention, picture exchange communication system, pivotal response training, prompting, reinforcement, response interruption/redirection, scripting, self-management, social narratives, social skills training, structured play group, task analysis, technology-aided instruction and intervention, time delay, video modeling, and visual support. In the first edition of the Wong et al. (2014) edition, Odom et al. (2010) identified the overlap between the two comprehensive reviews and noted that in several cases Odom et al. (2010) identified as stand-alone evidence-based practices what might be considered subcomponents of the evidence-based practices identified by Howard, Ladew, and Pollack (2009). For example, Howard et al. (2009) identified behavioral package as an evidence-based practice whereas Odom et al. identified separated behavioral interventions into several evidence-based practices (i.e., reinforcement, task analysis, discrete trial training, functional behavior analysis, functional communication training, response interruption/redirection, differential reinforcement). Notably, while some individual studies targeted isolated academic skills, no specific academic interventions were identified by either research group. However, Wong et al. identified DI as a promising practice. Further, both reviews limited inclusion of studies published on or before 2007 (Howard et al., 2007) or 2011 (Wong et al., 2014); a number of academic interventions have been investigated since then and will be reviewed in a later section of this chapter.

Research to practice implications. Kasari and Smith (2013) discussed the barriers to implementation of evidence-based practices in schools and provided recommendations to increase future implementation. The authors commended the work of Odom et al. (2010) for not only identifying evidenced-based practices, but also creating descriptions, implementation checklists, and materials for practitioners. However, they cautioned that even this level of detail is not enough. Kasari and Smith (2013) indicated that it is important to identify the components of a practice that are critical to success versus those that may be modified or excluded during implementation. Given the varied context of school settings and skills of practitioners this type of delineation is important to ensure salient features are not lost in translation in natural settings. In addition, the authors noted that while interventions are identified and described in detail, often it is less clear to which skills or outcomes the interventions should be applied to (e.g., what skills should task-analysis be used for teaching?). The authors stated that manuals would be a helpful option for facilitating and supporting effective implementation, with the caveat that the manuals need to provide opportunities for flexibility of implementation. Kasari and Smith also noted that often researcher goals and teacher goals are not aligned. Researchers have historically focused on interventions related specifically to ASD core deficits whereas the primary goal of teachers is to teach academics to students with ASD. In order to increase implementation of evidence-based practices, the authors suggested that researchers must develop interventions that address the priorities of the teachers in order to increase buy-in and likelihood of implementation. Further, the authors emphasized that the majority of ASD research has occurred in clinical settings outside of schools which often leads to interventions that are not feasible in the school setting or that have overlooked critical barriers or needs during development. This leads to delays in full scale implementation or outright rejection of the intervention by educators. Kasari and Smith (2013) emphasized the need for interventions to occur from the beginning whenever possible in the school setting so that feasibility and validity can be assessed adequately. Lastly, the authors indicated the importance of identifying interventions for outcomes that will produce durable effects that will translate beyond schooling and into adulthood for individuals with ASD (2013).

In summary, while early intervention is predictive of improved outcomes in elementarily school, post school outcomes of students with ASD continue to be overwhelmingly poor. Cognitive deficits including difficulties with joint attention, theory of mind, weak central coherence and executive functioning impact students' with ASD ability to access, interpret, prioritize, and achieve academic goals. This is reflected in discrepancies between achievement and cognitive ability by the majority of individuals with ASD. While there has been a rapid upturn in identifying effective interventions for individuals with ASD, few have targeted academic skills. It is imperative to identify academic interventions that will be effective and durable in school settings in order to maximize the potential of individuals with ASD.

Academic Interventions for Students with ASD

Definition and description of academic interventions. For the purpose of this review studies which target an academic skill as the dependent variable will be identified as an academic intervention. Given the extensive review of research conducted prior to 2007 by Odom et al. (2010) and Howard et al. (2009), which demonstrated limited research pertaining to academics for students with ASD, studies published before then will not be reviewed. In addition, given the purpose of the review, only studies which demonstrate positive effects of either statistical significance (group design) or a functional relation (single case design) and are scientifically rigorous based upon criteria delineated by Horner et al. (2005) will be included in this review of academic interventions. In addition, while there are certainly more academic subjects, only mathematics and reading interventions will be included. Finally, only studies which include a majority of school-aged participants (5 to 21-years-old) identified as having ASD will be reviewed. The purpose of this is to identify interventions developed specifically for individuals with ASD and demonstrated as effective with school-aged participants from this population.

Reading interventions. Whalon and Hanline (2008) investigated the effects of reciprocal questioning, self-monitoring, and visual cues on reading comprehension of three elementary students with ASD and average to above average intelligence. Using a multiple baseline across participants design results indicated a functional relation between the intervention and students' ability to generate and answer questions. Students were given story element and question word- cards, a self-monitoring checklist, and modeling with corrective feedback by the researcher during the first two intervention questions. Instruction occurred with a typically developing peer partner and one participant with ASD. The monitoring checklist prompted the student to generate a question after reading each page and responding to partner's questions. Using a multiple baseline across participants design results indicated a functional relation between the intervention and students' ability to generate and answer questions. The authors indicated that the use of direct comprehension strategy instruction is a promising approach to teaching reading comprehension to students with ASD.

Stringfield, Luscre, and Gast (2011) investigated the effects of a story map graphic organizer on story recall with three elementary boys with high functioning ASD. The intervention was implemented during one-on-one instruction. First, students were told explicitly what to write in each section of the story map during one instructional lesson. Then during the remaining intervention during story reading students were prompted to use the story map graphic organizer using a system of least prompts. The initial prompt was a verbal directive to reference the text to complete the current section of the story map, if no response or an incorrect response, the teacher turned the page of the book to the selection containing the answer. If no response or an incorrect response, the teacher pointed to the sentence containing the answer. Finally, if still no response or an incorrect response, the teacher read the sentence aloud and told the student to write the answer in the story map. This procedure was repeated as needed for each section of the graphic organizer. Following completion of the story map, participants completed an Accelerated Reader assessment which measured story recall. Using a multiple baseline across participants design, results indicated a functional relation between the use of the story map graphic organizer and story recall. The authors indicated that the findings of this study contribute to the literature demonstrating the effectiveness of graphic organizers for increasing comprehension skills of individuals with ASD.

Additionally, Bethune and Wood (2013) investigated the effects of graphic organizers on reading comprehension of three elementary students with ASD ages 8 and 10-years-old. Inclusion criteria required oral reading at 1st grade level, ability to match nouns to pictures, difficulty answering “wh” questions, and difficulty using a graphic organizer to sort information to corresponding “wh” question type. The primary dependent variable was correct answers on literal recall “wh” questions. The authors also collected data on participants’ correct sorting of words into “wh” question categories on the graphic organizer. The intervention consisted of providing least to most prompting to sort eight words (two each for who, what, when, where) into corresponding sections on a “wh” graphic organizer. Participants were then presented with a novel 1st grade reading passage and asked to answer eight literal recall comprehension questions (two each for who, what, when, where). Participants were told they could use the graphic organizer or reference the text as needed to answer the questions. Using a delayed multiple baseline across participants design results indicated a functional relation between the graphic organizer intervention and answering comprehension questions. In addition, participants improved in word sorting using the graphic organizer from baseline to intervention. Further, participants maintained their ability to correctly respond to comprehension questions three to five weeks following intervention. Generalization measures using participants’ answers to literal comprehension questions during Direct Instruction lessons were collected during baseline and maintenance. Baseline generalization scores ranged from 0% to 40% and scores obtained during maintenance ranged from 75% to 100%. The authors indicated that graphic organizers can support students’ with ASD answer literal comprehension questions.

Carnahan and Williamson (2013) investigated the effects of a compare/contrast intervention package on the comprehension of expository text of three 13 year-old students with ASD and moderate intellectual disability. The intervention package consisted of strategically constructed passages of science text with clearly embedded compare and contrast key words and concepts, a handout of compare and contrast key words, a Venn diagram, and explicit teacher implemented instruction in recognizing compare and contrast key words and identifying similarities and differences of concepts within text. Instruction was provided in a small group consisting of all participants. Using an ABAB reversal design results indicated a functional relation between the compare contrast intervention package and percent correct comprehension questions for all three students. The authors indicated that this study adds to the literature demonstrating that students with ASD benefit from systematic and explicit instruction. A limitation of this study is the use of highly controlled expository passages as this may limit generalizability to less structured, more typical expository text. In addition it may pose a problem with feasibility given the time it would take for a teacher to construct the expository text may lead teachers to choose not to use the intervention. As stated by Kasari and Smith (2013), interventions which require a great deal of preparation or interpretation are unlikely to be used by classroom teachers.

Muchetti (2013) investigated the effects of teacher-implemented shared story reading on comprehension and activity engagement with four students with ASD ages 6 to 8-years-old identified as minimally verbal and demonstrating moderate to severe intellectual disability. Instruction occurred in a private school one-on-one with the participants’ teacher. The shared story intervention included simplified adapted text, embedded picture symbols, response boards, and corresponding objects related to the story. Teachers followed a task analysis for each lesson and provided a system of least prompts to support participants as needed when asked to respond to comprehension questions. The authors used a multiple baseline across participants design with an embedded modified alternating treatments design to assess intervention effects on comprehension and activity engagement. During baseline, participants were read three unadapted books and asked comprehension questions. During intervention, two books were adapted with materials and prompting provided, while one book remained unadapted. Books were taught on alternate days and counterbalanced across participants. Results indicated a functional relation between shared story reading and answering comprehension questions and activity engagement. Limitations of this study include implementation in a private school setting and using one-on-one instruction which is less feasible in most school settings. The authors suggest future research include group instruction.

Mathematics interventions. Cihak and Foust (2008) compared the effects of teacher- implemented number lines and touch points instruction on single-digit addition problem solving with three elementary students with ASD and moderate intellectual disability ages 7 to 8-years-old. During intervention teachers used model-lead-test to instruct the students on using the number lines or touch points to complete the single-digit addition problems. Using an alternating treatments design, results indicated a functional relation between touch points and correct single-digit addition for all three participants. Two of the students demonstrated improvement from baseline using number lines, but the slope was much less steep than demonstrated by the use of touch points. Limitations to this study include the use of one-on-one instruction and teaching only one subset of mathematics.

Rockwell, Griffin, and Jones (2011) investigated the effects of schema-based strategy instruction on solving addition and subtraction problems with a 10-year-old girl with ASD. Schema-based strategy instruction involves providing schematic diagrams representing the patterns of different types of problems that assist individuals with understanding and solving the problem. The experimenters used model-lead-test to teach the participant to first sort different types of problems based on their schema and then solve problems. The intervention was implemented by the researcher one-on-one in a home office. Using a multiple baseline across problem types results indicated a functional relation between schema-based strategy instruction and addition and subtraction problem solving. A limitation of this study was the implementation of the intervention outside the school setting and lack of generalization measure to determine if the participant was able to demonstrate the skills under different conditions in different settings. The authors indicated that this type of explicit instruction helps participants identify the problem type and select the appropriate strategy and addresses executive functioning deficits which contribute to difficulties in solving mathematical problems.

In addition, Whitby (2013) discussed how problems with executive functioning may contribute to completing mathematical problems. The author investigated the effects of a problem solving routine curriculum called, “Solve It!” on the percent correct of multi-step word problems by three middle school students with ASD and IQs ranging from 90-107. The Solve-It! curriculum included scripted lessons, pre-/post assessments, strategy cue cards, and strategy posters. It taught students to read, paraphrase, hypothesize, estimate, compute, and check when completing word problems. In addition, students were taught to think about the process by self-managing, self-questioning, and self-evaluating during each step of the process. Using a multiple-baseline across participants design results indicated a functional relation between the Solve It! curriculum and correct problem solving. The author stated that explicit instruction to teach cognitive and metacognitive strategies may support students with ASD, who demonstrate executive functioning deficits, in linking process such as problem solving strategies to a variety of specific problems. A strength of this study was the use of curriculum with scripted lessons which may provide consistency of implementation across instructors and increase feasibility of implementation for practitioners. A limitation of the study was the use of one-on-one instruction in a separate classroom.

Burton, Anderson, Prater, and Dyches (2013) conducted their study one-on-one with participants, but instruction was provided in the participants' classroom by the classroom teacher and paraeducators. The authors investigated the effects of video self-modeling via an iPad on percent correct steps completed in solving story problems involving purchasing skills. The teacher trained the paraeducators to present the story problems, observe, collect data, and provide specific praise as the students completed the problems. Following baseline, the teacher provided a script and prompted students to complete the problem, then edited the video to remove prompting so the video displayed the student completing each step of the problems. Next, students were provided the script and the video model and told to complete the problems. After the initial video self-modeling phase, the teacher systematically removed known problems one at a time and replaced them with novel problems until students were completing all novel problems by the last phase of intervention. Results indicated a functional relation between video self-modeling and correct completion of story problems involving purchasing skills. A strength of this study was that researchers linked the skill to mathematics common core state standards which may support buy-in and future implementation by practitioners who prioritize academic instruction.

Bouck, Satsangi, Doughty, and Courtney (2013) compared the effects of virtual manipulatives and concrete manipulatives on completion of subtraction problems by three participants with ASD ages 7 to 10-years-old. Instruction occurred in a non-profit ABA clinic using one-on-one instruction. Concrete manipulatives consisted of connecting base-ten blocks or online manipulatives representing base-ten blocks on a free access mathematics website. Researchers used a system of least prompts to teach participants to use both types of manipulatives. Participants were assessed on percent correct completion of problems and percent of steps completed independently. Using an alternating treatments design results indicated that use of virtual manipulatives resulted in more efficient acquisition of independent responding, however both types of manipulative use demonstrated improved responding leading to 100% correct responding over time.

Summary of academic interventions for students with ASD. Reading research has primarily targeted reading comprehension (Carnahan & Williamson, 2013; Muchetti, 2013; Stringfield et al., 2011; Whalon & Hanline, 2008) using a variety of intervention strategies including reciprocal questioning (Whalon & Hanline, 2008), self-monitoring (Whalon & Hanline, 2008), visual cues such as checklists or graphic organizers (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Stringfield et al., 2011; Whalon & Hanline, 2008), system of least prompts (Muchetti, 2013; Stringfield et al., 2011), adapted text (Carnahan & Williamson, 2013; Muchetti, 2013), task analysis (Muchetti, 2013), and explicit instruction (Carnahan & Williamson, 2013; Stringfield et al., 2011; Whalon & Hanline, 2008). Two of the four studies reviewed included participants with ASD identified as high functioning (Stringfield et al., 2011; Whalon & Carnine, 2008), and two studies targeted individuals with ASD and moderate to severe intellectual disability (Carnahan & Williamson, 2013; Muchetti, 2013). Limitations of the reading research included the use of one-on-one instruction (Muchetti, 2013; Stringfield et al., 2011) which is typically not feasible in public school classrooms where the majority of individuals with ASD are served and the use of highly tailored adapted text (Carnahan & Williamson, 2013; Muchetti, 2013) which may limit research to practice given the limited time resources available to the majority of classroom teachers.

Similarly, research in mathematics focused primarily on a narrow range of skills, specifically simple operations. Addition and/or subtraction were targeted by four of the studies reviewed (Bouck et al., 2013; Burton et al., 2013; Cihak & Foust, 2008; Rockwell et al., 2011), while one study targeted all four operations (i.e., addition, subtraction, multiplication, division; Whitby, 2013). Intervention strategies were varied and included model-lead-test (Cihak & Foust, 2008; Rockwell et al., 2011), graphic organizers (Cihak & Foust, 2008; Rockwell et al., 2011), manipulatives (Bouck et al., 2013; Burton et al., 2013), technology (Bouck et al., 2013; Burton et al., 2013), system of least prompts (Bouch et al., 2013), and scripted explicit lessons (Whitby, 2013). As with the reading research, one limitation is that all of the studies utilized one-on-one instruction. Further, two of the studies were implemented in private settings (Bouck et al., 2013; Rockwell et al., 2011) which limits translation to classroom settings. That said, overall, the mathematics research demonstrated several strengths related to feasibility of implementation in school settings including implementation of instruction by classroom teachers (Burton et al., 2013; Cihak & Foust, 2008), instruction in the classroom setting (Burton et al., 2013; Cihak & Foust, 2008; Whitby, 2013), the use of a scripted curriculum (Whitby, 2013), and alignment to the common core state standards (Burton et al., 2013).

Direct Instruction

The following section will provide a detailed description of DI and review the seminal study, Project Follow Through, which demonstrated widespread effectiveness of DI in teaching at-risk students. Next, research on the use of DI to teach students with disabilities will be discussed. Finally, studies investigating the effects of DI with students with ASD will be reviewed.

Definition and description of DI. Watkins, Slocum, and Spencer (2011) define Direct Instruction (DI) as “the specific systematic approach to curriculum analysis, instructional design, and teaching principles developed by Siegfried Engelmann and Wesley Becker” (p. 298). Within the three main domains of DI are specific features (Watkins & Slocum, 2004; Watkins et al., 2011). Curriculum design includes content analysis, clear communication, instructional formats, sequencing of skills, and track organization. Instructional design includes instructional grouping, instructional time, scripted presentation, and continuous assessment. Teaching principles include active student participation, group unison responses, signals, pacing, teaching to mastery, correction procedures, and motivation. See Table 1 for definitions of features within each component.

Table 1: DI core features defined

DI core features	Definition
<u>Curriculum design</u>	
Content analysis	Identifying "concepts, rules, strategies, and 'big ideas'" (Watkins & Slocum, 2004, p. 76) of a content area
Clear communication	Precise teaching of concepts that enables the student to understand the specific concept and the range of examples of the concept (e.g., concept is dog, range of examples are poodle, pug, and great dane)
Instructional formats	Clear, consistent presentation of concepts. During initial instruction formats are overt, simple, provide prompting. include massed trials, provide immediate feedback, and are teacher directed. As students increase understanding, formats become more covert, complex, unprompted, include distributed practice, provide delayed feedback, and are student directed.
Sequencing of skills	Prerequisite skills are taught first, common rules are taught and mastered before teaching exceptions to the rules, easy tasks are taught before hard tasks, concepts that are easily confused with one another are taught separately
Track organization	Tracks are skills within a related concept. Track organization involves teaching tracks across several lessons and teaching several tracks within one lesson (e.g., tracks in mathematics include addition, measurement, and time; one lesson might teach components of several tracks such as skip counting, estimating length, and identifying the number hand.) Each track is taught sequentially until mastered.
<u>Instructional design</u>	
Instructional grouping	Students are grouped according to ability level to meet the needs of individual abilities, groups are fluid (e.g., students may move from one group to another depending upon individual performance)
Instructional time	Time should be used efficiently so that maximum amount of students' time is spent actively engaged in learning
Scripted presentation	Explicit scripts with clear, detailed wording and instructions are used to ensure students are receiving expertly designed instruction and remove the onus from teachers to develop complex explicit instruction
Continuous assessment	Students are provided regular and varied assessments to determine appropriate instructional grouping and/or make instructional decisions such as skipping ahead or increasing pace of instruction.

Teaching principles	
Active student participation	Overt student interaction with instructor and instructional materials
Group unison responses	Simultaneous responding to instructor directives, responses can be choral, gestural, or written.
Signals	Instructor provided cue to elicit group unison responses, may include tapping, pointing, clapping, snapping, head nodding, etc.
Pacing	The speed at which instruction occurs, DI recommends rapid pacing to cover maximum amount of content and maintain student attention
Teaching to mastery	Skills are taught until students consistently demonstrate successful use of skill, the teacher does not move on to next skill in sequence until previous skill is mastered
Correction procedures	Student mistakes are immediately corrected using a model-test approach, this involves demonstrating or reteaching the skill and then immediately prompting the students to perform the skill again. If skill is particularly difficult for students, the teacher may provide a model-lead-test correction in which the teacher models the skill, then performs the skill simultaneously with the students, and finally has the students perform the skill independently.
Motivation	DI assumes that students are motivated when they are successful, so the primary motivation strategy is setting up students for success by providing clear instruction which scaffolds skills in such a way that students are consistently successful in demonstrating new skills. In addition, immediate reinforcement is provided for correct responding during initial learning of skills and provided intermittently for demonstration of mastered skills.

Note. Definitions were derived from Watkins and Slocum (2004).

Project Follow Through. Project Follow Through was a federally funded initiative from the U.S. Office of Education titled the “Follow Through Program” and was developed to support the continuing education of economically disadvantaged children who had previously received Head Start preschool instruction prior to entering elementary school (Department of Health, Education, and Welfare, 1974). Project Follow Through was a longitudinal study of 9 different educational models serving up to 75, 000 students in 170 communities yearly nationwide (Engelmann, Becker, Carnine, & Gersten, 1988). The models included (a) Direct Instruction (described above); (b) Behavior Analysis, which used the principles of behavior analysis to teach mastery of academic subjects and provide group contingency reinforcement; (c) Parent Education, which did not use a particular teaching strategy or curriculum but focused on increasing parent involvement in classroom instruction; (d) Tucson Early Educational Model, which emphasized a student lead approach to language learning and positive attitudes towards skill development; (e) Cognitively Oriented Curriculum, focused on improving reasoning skills of students, followed student self-selected schedule, and used teacher as facilitator rather than instructor; (f) Responsive Education, emphasized student-paced learning, student self-esteem, and providing a rich learning environment accessible to students; (g) Bank Street, prioritized positive self-image and self-expressive language, and did not emphasize a particular mode of instruction (h) Open Education, also involved student led learning, buildings were specially designed to allow movement throughout classroom areas with removal of walls between classes; and, (i) The Language Development Approach, which included simultaneous bilingual education and emphasis on students native culture (Watkins & Slocum, 2004). Students were assessed in three primary areas: basic skills, cognitive skills, and affect. Basic skills included word identification, spelling, computation, and language. Cognitive skills included reading comprehension and mathematics problem solving. Affective measures assessed students' self-concept (Watkins & Slocum, 2004). Results indicated significant positive outcomes in all three areas with students who received DI. Only three other approaches (Behavior Analysis, The Language Development Approach, and Parent Education) demonstrated positive effects and none were as significantly improved as DI. Only DI demonstrated positive effects in all three domains. The remaining models demonstrated significantly negative outcomes in all three assessed areas (Engelmann et al., 1988). Unfortunately, these outcomes were never widely disseminated and rather than moving towards comprehensive implementation of DI across all sites, Project Follow Through declared that there was not a clear forerunner in the study and allowed sites to select their preferred model for implementation. Funding and implementation of Project Follow Through continued until 1995 (Watkins & Slocum, 2004). As a result, although DI demonstrated highly effective results for student learning it has never become a mainstream approach to instruction. It is hypothesized that this is due to the highly structured teacher-directed instructional presentation which is counterintuitive to many educators who prefer a more constructivist approach to teaching which emphasizes guiding students to construct their own meaning (Engelmann, 2007).

Students with disabilities. Although DI was originally developed for typically developing children who were economically disadvantaged, implementation of DI has been shown to be effective in teaching students with disabilities (Gersten, 1985; Kinder et al., 2005; White, 1988). Gersten (1985) conducted a review of six empirical studies investigating the effects of DI on skill acquisition of students in special education. A review of the results indicated students in special education demonstrated higher academic achievement and/or skill acquisition from DI than from traditional approaches to instruction. Gersten (1985) indicated the need to identify the components of DI that are most salient for success of students with disabilities and to determine what strategies may need to be adapted to meet the specific needs of students with disabilities.

White (1988) conducted a meta-analysis of 25 studies investigating the effects of DI with students with disabilities. Studies targeted participants with disabilities ranging from mild (n=21), moderate (n = 2), to severe (n=1) in grades 1-12. Thirteen of the studies investigated the effects of DI on reading ability, four on mathematics ability, and eight on language ability. Results indicated that 53% of the studies demonstrated statistically significant differences favoring DI intervention. None of the studies favored the comparison groups. The remainder of the studies, while not demonstrating significant differences, resulted in greater gains for participants receiving DI. White indicated that results of these studies showed that DI was equally effective for all levels of disability.

In a more recent review of DI literature, Kinder et al. (2005) identified 37 studies investigating the effects of DI on academic skills of students with disabilities. The authors divided their review of studies into two groups: studies that included participants with high incidence disabilities and studies that primarily targeted individuals with low incidence disabilities. The authors described high incidence disabilities as including learning disabilities, communication disorders, behavior disorders and mild mental retardation and identified 29 studies examining the effects of DI with this population. They described low incidence disabilities as including ASD, traumatic brain injury, and moderate to severe mental retardation and located eight studies investigating the effects of DI with this population. The authors noted that the use of the DI reading curricula with students with high incidence disabilities demonstrating positive results is fairly established. They noted that further research is needed to examine the effects of DI on writing and mathematics with students with high incidence disabilities. Six of the eight studies investigating the effects of DI with students with low incidence disabilities involved implementation of DI reading and/or language curricula, one study investigated the effects of DI mathematics curricula, and one study investigated a combination of all three types of DI curricula on skill acquisition of students with low incidence disabilities. Only one of the studies included participants with ASD. All of the studies with students with low incidence disabilities demonstrated positive outcomes. The authors indicated that most of the studies included participants with IQs between 30-50 and that the majority of these participants learned to read and/or master language skills as a result of DI implementation. In addition, the authors noted that efficiency of DI in increasing skill acquisition of students with low incidence disabilities, and stated that learning gains were rapid. Further, the authors emphasized that few studies investigated the effects of DI curriculum to teach mathematic skills to students with disabilities and identified the need for further research in this area. Finally the authors indicated that DI appears to be highly effective in increasing academic skills with students with disabilities, including those with the most severe disabilities.

Students with ASD. Recently there has been research investigating the effects of DI on academic skill acquisition of students with ASD. Watkins (2008) possibly spurred this research by indicating the complementary fit between DI and characteristics of individuals with ASD. Watkins identified five core features of DI that seemed particularly suited to meeting the educational needs of individuals with ASD: general case programming, formats, track organization, scripted presentation, and pacing. In a follow-up discussion of the fit between ASD and DI, Watkins et al., (2011) included discussion of the five features identified by Watkins (2008) and expanded the suitable core features to include instructional time, continuous assessment, correction procedures, and motivation. The remainder of this section will review the two articles' (Watkins, 2008; Watkins et al., 2011) discussion of the fit between these core features of DI and the characteristics of ASD. Finally, all known rigorous studies (i.e., meeting Horner et al. [2005] criteria) investigating the effects of DI on the academic skill (i.e., mathematics or reading) acquisition of students with ASD will be reviewed.

General case analysis was not identified as a core feature of DI, but directly relates to the feature described as clear communication (Watkins & Slocum, 2004). General case analysis is the process of identifying all the possible variations of a concept, determining the fewest number of examples needed to support comprehension of all the different types of variation, and then teaching these examples of the general case (Watkins & Slocum, 2004). Many individuals with ASD demonstrate weak central coherence, which impacts their ability to generalize knowledge to novel stimuli or situations. By using general case analysis, DI helps to address this deficit by explicitly teaching stimulus generalizations (Watkins et al., 2011). The use of instructional formats in DI which provide precise, consistent frameworks for introducing similar concepts provides predictability and reduces cognitive load for students with ASD who often have difficulty with working memory as well as focusing on salient features of instruction (Watkins, 2004; Watkins et al., 2011). The DI core feature of track organization provides the opportunity for task interspersal and variation during lessons both of which have been demonstrated as effective strategies for increasing efficiency of skill acquisition in students with ASD (Watkins et al., 2011). Scripted presentations provide similar benefits of consistently and predictability for students with ASD, similar to the use of instructional formats (Watkins, 2004). In addition, scripts allow for consistency of presentation across instructors, particularly in the area of consistent wording which may increase comprehension and benefit students with ASD whose language deficits may otherwise impede learning (Watkins et al., 2011). This also pertains to why the DI correction procedures, which also provide predictability and consistency, may be well matched to supporting students with ASD. Watkins et al. (2011) indicate previous research (e.g., Koegel, Dunlap, & Dyer, 1980) has demonstrated brief intertrial intervals result in increased learning by individuals with ASD. Therefore the DI feature of brisk pacing should support increased skill acquisition of students with ASD (Watkins, 2004; Watkins et al., 2011). Also, the high rates of active student response occurring as a result of brisk pacing increase student engagement and provide repeated opportunities to support improvement joint attention, both of which have been demonstrated as increasing academic performance in students with ASD (Watkins et al., 2011). Watkins et al. (2011) explain the emphasis of DI on maximizing instructional time complements research indicating active engagement of students with ASD is a strong predictor of academic success (e.g., Iovannone, Dunlap, Huber, & Kincaid, 2003). The authors compared the DI feature of continuous assessment to the behavior analytic practice of data-based decision making for students with ASD. Given students' with ASD varied skill levels (e.g., high level of sight word reading accompanied by low level of comprehension), continuous assessment assists with ensuring instructional methods are appropriate across academic domains. Finally, Watkins et al. (2011) noted the DI assumption that motivation is directly tied to rate of success and resulting structuring of teaching to provide minimized to errorless learning aligns with research indicating that high levels of success have resulted in motivation of students with ASD (e.g., Munk & Repp, 1994). The following studies support Watkins and colleagues hypothesis of the suitability of DI and ASD.

Reading. Flores and Ganz (2007) investigated the effects of a DI program, *Corrective Reading Thinking Basis: Comprehension Level A* (Engelmann, Haddox, Hanner, & Osborne, 2002), on statement inferences, using facts, and analogies of four elementary students, two of which were diagnosed with ASD. Review of the results of this study will be limited to the results of the students with ASD. No specific criteria were delineated for participation in the study. Students attended a private school for students with ASD and intellectual disability. The participants with ASD demonstrated average intelligence, were in grades five and six, and were ages 11 and 14 years old respectively. There were two participants without ASD, one identified with mild mental retardation and the other with attention deficit hyperactivity disorder. The intervention consisted of teaching only the segments of the curriculum related to statement inferencing, using facts, and analogies. The researchers indicated they followed the scripts and procedures as directed by the curriculum, including group responding. They made one modification to the curriculum by adding picture cues with written facts to support using facts instruction, which was presented orally within the curriculum. The authors indicated that the picture cues, then written facts were faded out over the course of instruction, but did not indicate the decision process guiding the fading procedure. The researchers varied the person providing instruction by switching roles (i.e., instructor versus data collector) several times each week. Probes were provided to participants two to three times per week prior to instruction. Using a multiple probe across behavior design, results indicated a functional relation between DI and statement inferencing, using facts, and analogies for both participants with ASD. In addition, they both demonstrated 100% accuracy on probes for each behavior one month following cessation of the intervention. The authors identified the following limitations: implementation of only a portion of the DI program, conducting the study in a private school, use of researchers to implement the study instead of classroom teachers. They suggested that future research include implementation by classroom teachers in a typical classroom, implementation of the full curriculum, and inclusion of curriculum-based assessments (Flores & Ganz, 2007).

In a follow-up study, Flores and Ganz (2009) extended their research to include additional components of the previously described DI comprehension program, curriculum-based assessments, and standardized assessments. There were four participants: two with ASD who demonstrated average IQs, one with mental retardation, and one with attention deficit hyperactivity disorder. The dependent variables for this study included comprehension of picture analogies, deductions, and inductions. Probes were provided to participants two to three times per week, and curriculum-based and standardized assessments were provided pre- and post-intervention. The curriculum-based assessment used was the placement test provided by the DI curriculum. The standardized assessment was running record that included an orally read passage followed by comprehension questions. Again the curriculum procedures were followed as directed, including the use of group instruction to teach the skills and the researchers implemented the instruction. In this study, no modifications were provided to participants. Using a multiple probe across behavior design, results indicated a functional relation between DI and picture analogies, deductions, and inductions for both participants with ASD. One month following the intervention, one student with ASD maintained mastery criteria for two of the three behaviors and the other student with ASD demonstrated decreased performance across all three behaviors. Results of curriculum-based pre- and post-tests showed a decrease of 24-25 errors to 10-11 errors in the placement test. Results of the standard based measure demonstrated an increase of answering comprehension questions from zero to one correct answer to two correct answers following oral reading of a second grade passage. The authors indicated results of this study extend the previous research demonstrating DI may be an effective strategy for teaching comprehension to individuals with ASD and developmental disabilities. They suggested additional research include instruction in the DI curriculum in its entirety, as well as effects of long term instruction using DI with students with ASD and developmental disabilities. While not explicitly stated by the authors, the authors indicated participants had received previous instruction in DI and the participants of this study were reported to have the same descriptions of the previous study (i.e., same IQs, same reading achievement scores, same diagnostic criteria, same gender, same grade), therefore it is likely the same participants were used in both studies. This may indicate multiple-treatment interference and limit generalizability of results.

Flores et al. (2013) extended the literature further by investigating the effects of whole lesson implementation of the same DI curriculum, *Corrective Reading Comprehension: A Thinking Basics Program* (Engelmann et al., 2002) and an additional curriculum *Language for Learning* (Engelmann & Osborne, 1999) on comprehension and language skills. Eighteen participants, including 11 with ASD, were selected based on their performance on DI placement tests. No other inclusion criteria were indicated.

Participants ranged in age from 8 to 13-years-old in grades 1st through 7th. Participants IQs ranged from 55 to over 100 with the majority falling between 55 and 85. All participants were receiving extended school year based on their IEP, which was provided in a university sponsored setting. Based on placement tests participants were divided into two groups: individuals who placed into the reading comprehension DI program were placed in one group, and the remaining participants who did not place into the reading group were assigned to the language DI program and provided placement tests for that curriculum. Participants were placed in groups ranging from two to four and received whole lesson unmodified instruction following the procedures outlined in the curricula including group responding. The authors used a one-way within subjects analysis of variance; the factor was time and the dependent variable was percent correct on curriculum based measures (i.e., placement tests, mastery tests, and researcher created tests based on curriculum). Results indicated statistically significant improved scores on measures from the pre-assessment to the final mastery tests in both groups. The authors stated that this research adds to demonstration that students with ASD and ID can participant in DI instruction, including group responding and benefit from group instruction. The authors stated that while classroom teachers were implementers in this study, they had participated in specialized university DI training, that may not be typical to regular school settings. Another limitation included the implementation in a university setting instead of a typical classroom setting. The authors suggested future research include instruction in typical school setting implemented by classroom teachers with general level of training.

Mathematics. To date there is only one known DI mathematics study with students with ASD. Thompson, Wood, Test, and Cease-Cook (2012) investigated the effects of DI on telling time by students with ASD. Inclusion criteria included elementary aged individuals with ASD who demonstrated vocal-verbal behavior, demonstrated understanding of the concept “before”, identified numbers to 12, counted fluently by five to 60, and had a diagnosis of ASD. Three participants aged 6 and 8-years-old in grades 1st and 3rd were included in the study. The experimenter was the classroom teacher. Instruction occurred one-on-one in a separate tutor room within the public school. The intervention included portions of *Connecting Math Concepts Level B* (Engelmann, Carnine, Kelly, & Engelmann, 2003) related to telling time. Probes were worksheets with nine analog clocks that differed slightly in topography from the analog clocks shown in the DI curriculum. The dependent variable was number correctly identified time on probes. In addition, a generalization measure was taken during baseline and following intervention measuring participants’ ability to tell time using actual clocks located in nine different settings throughout the school. Further, social comparison data were collected from five typically developing general education students in second grade, which is the grade in which telling time is taught according to the state’s the standard course of study. Using a multiple probe across participants design results indicated a functional relation between DI instruction and telling time across participants; however, none of the participants achieved mastery in telling time (i.e., all nine correct for three consecutive sessions) and generalization of telling time was low (i.e., participants generalization probes during maintenance ranged from 0-4). Notably, all three participants performed as well as or better than the typically developing students who completed the probe and generalization measure, indicating that DI supported students with ASD to achieve grade level performance in telling time. The authors indicated that this study extends the research to demonstrate that DI may be effective in teaching mathematics skills. The authors noted limitations to the study including not teaching the skill to mastery, teaching only one mathematics concept as opposed to the full DI curriculum, and providing the instruction one-on-one with participants.

Summary of DI. Only four rigorous experimental studies teaching reading or mathematics have been implemented to date using DI with students with ASD (Flores & Ganz, 2007, 2009; Flores et al., 2013; Thompson et al., 2012). All demonstrated positive outcomes for students with ASD in acquiring targeted skills. Three of the four studies were implemented in settings other than the typical public school (e.g., private school for students with ASD and intellectual disability; Flores & Ganz, 2007, 2009; Flores et al., 2013). Two of the studies used classroom teachers as implementers (Flores et al., 2013; Thompson et al., 2012). Three of the studies used the same curriculum (i.e., *Corrective Reading Comprehension: A Thinking Basics Program*, Engelmann et al., 2002) and taught reading comprehension skills (Flores & Ganz, 2007, 2009; Flores et al., 2013). Only one implemented DI using whole lesson instruction (Flores et al., 2013). Three of the studies implemented DI using group instruction (Flores & Ganz, 2007, 2009; Flores et al., 2013); however, none of these studies included specific criteria for participant inclusion (e.g., did students demonstrate previous group participant behaviors or compliance during group instruction?) or report quantitative data on group responding behaviors. Further, all three of the studies which used group instruction included participants without ASD who do not typically demonstrate social deficits as a result of their disability and thus may have provided modeling which may have supported group responding behavior of students with ASD.

Group Instruction

Group instruction can be more efficient than one-to-one instruction (Konrad, Helf, & Joseph, 2011). Watkins et al. (2011) explain, “well designed small-group instruction provides the effectiveness of one-to-one instruction in a more efficient format” (p310). In fact, Ruble and Robson (2007) found students with ASD were most likely to be compliant and demonstrate behaviors aligned with academic goals during small group instruction as opposed to large group instruction, one-on-one instruction, and independent work. This is an important distinction given students with ASD are often taught in one-on-one instruction (Arick et al., 2011; Ledford, Lane, Elam, & Wolery, 2012). It is crucial to identify effective ways to provide instruction that is efficient and cost effective in order to increase implementation in public schools, which are restrained by ever decreasing budgets (Arick et al., 2011). Weiss (2013) identified the following specific behaviors necessary for effective group instruction: explicitly teaching rules for group participation, providing opportunities for unison group responding, interspersing high-probability requests, teaching students to self-monitor attending behaviors, and praising appropriate group behaviors. Within the field of low incidence disabilities, there has been inconsistent use of these practices. Snell and Brown (2011) described the common types of group instruction provided to individuals with severe disabilities (first described by Reid & Favell, 1984) which include tandem instruction, described as typically being used with learners naïve to group instruction and involves beginning with a student in a one-on-one setting and gradually adding students during the lesson; sequential instruction, where students are seated in a group arrangement but provided instruction one at a time while the other students watch; concurrent instruction, which is described as direct instruction involving unison responding; and combination groups where sequential instruction is interspersed with concurrent instruction. The following section will discuss two literature reviews investigating the use of group instruction with students with severe disabilities. The next section will include a review of individual studies using group instruction specifically with participants with ASD.

Students with severe disabilities. Reid and Favell (1984) conducted a literature review of studies using group instruction with participants with severe disabilities. The authors separated their review into two types of articles: those comparing group verses individual instruction and those investigating group instruction on skill acquisition. They indicated that results of the studies comparing group versus individual instruction were mixed, with no clear method of instruction outperforming the other. However, 80% of the articles reviewed demonstrated that group instruction was an effective mode to increase skill acquisition in participants with severe disabilities. The authors indicated that no type of group instruction was demonstrated as more effective than another. Reid and Favell (1984) suggested that future research should evaluate the optimal physical arrangements for group instruction, address efficient and feasible ways to manage disruptive behavior during group instruction, and identify explicit and effective ways to train teachers to implement group instruction. Finally, the authors emphasized the need to determine how and under what conditions group instruction is optimal for teaching individuals with severe disabilities.

More recently, Ledford et al. (2012) reviewed research on small group direct instruction to determine the outcomes and procedural variations of the articles included. The authors defined small group direct instruction as group instruction that uses response-prompting procedures to teach discrete skills to students. This differs from DI as described previously in this chapter and should not be confused with group DI; however, the definition does encompass studies utilizing DI and one was included in this review (i.e., Ganz & Flores, 2009). The authors identified 47 studies that included 197 participants. Twenty-four of the studies included teaching word-reading to students, nine included instruction on answering factual questions, and seven included teaching naming of pictures or other stimuli. The remaining studies taught identifying abbreviations (n=4), mathematics computation (n=3), identifying areas on a map (n=3), spelling words (n=2), defining words (n=2), pointing pictures (n=2), naming manual signs (n=2), pretend play (n=1), social initiations (n=1), and matching (n=1). Notably, mathematics computation was the only mathematics skill taught. Fifty-seven percent of the studies reviewed included participants with mild-to-severe developmental disabilities. Forty-nine percent of participants were in elementary school. The majority of studies included inclusionary criteria that required students to imitate a controlling prompt, attend during group instruction, and remain in their seats during group instruction. The authors stated that this indicated that small group instruction has not been adequately researched for individuals who are naïve to group instruction and may not be appropriate for all students. Forty-one of the studies were conducted in self-contained settings and 37 of the studies included groups of three to four students. Forty studies included only students with disabilities in the small groups. Only three studies included choral responding and, of those, error correction, simultaneous prompting, or constant time delay was used. Of these three studies, one included participants with ASD (Ganz & Flores, 2009) and one with participants identified as moderately mentally retarded (Wolery, Ault, Doyle, Gast & Griffin, 1992). Twelve studies used attending cues (e.g., “everybody, look”). Based on the findings of this review, the authors indicated future research should investigate procedures for teaching group participation skills (e.g., attending, turn taking, remaining seated). They indicated the use of general attending cues might be more efficient than individual cues and suggested future research identify effective cues for group instruction.

Students with ASD. Kamps, Dugan, Leonard, and Daoust (1994) stated that students with ASD traditionally receive sequential individual responding as opposed to opportunities to respond in unison. Sequential responding can greatly decrease students’ opportunities to respond. They investigated the effects of enhanced small group instruction on total student responses, task acquisition, and duration of engagement on academic tasks with students with ASD and students with moderate mental retardation. The enhancements included teacher-implemented interspersal of individual responding, choral responding, student-to-student responding, and a 5 min rotation of materials. Tasks involved demonstrating expressive and receptive comprehension of five common categories (e.g., household items, clothing) through activities such as identification, match to sample, and classification. Results indicated a functional relation between enhanced group instruction and all three dependent variables with participants with ASD. Limitations include the lack of description of inclusionary criteria for the participants with ASD, and descriptions of prompting procedures provided for teaching choral responding.

Ledford, Gast, Luscre, and Ayres (2008) investigated the effects of small group instruction using constant time delay to teach sight words on the incidental learning of six elementary students with ASD ages 5 to 8-years-old in K to 2nd grade. The authors indicated students had prior experience with constant time delay and sight word instruction, but did not indicate whether students had previous experience with group instruction or discuss inclusionary criteria. Intervention occurred in small groups of two students and one instructor. The authors indicated during the discussion that students in this study were compliant and demonstrated an absence of aggressive behaviors. Students participated sequentially during group instruction and data were collected on the number of skills students learned that were not taught directly to them, but to the other student in the group. Following intervention participants were able to identify 89 to 96% of observational targets (up from 0% prior to intervention). The authors stated that results indicated small group instruction was an effective mode of teaching and that students with ASD are able to learn by observation during small group instruction. A limitation of this study was that the groups were the smallest possible ratio (i.e., groups of two) and future research should include more participants in small group instruction.

Leaf et al. (2013) compared the effects of discrete trial teaching during one-on-one instruction to small group instruction on skill acquisition of six students with ASD ages 3 to 8-years-old. The authors used the following criteria to select participants: diagnosis of ASD, IQ of 85 or higher, ages 3 to 8-years-old, and previous instruction using discrete trial training in individual and group instruction arrangements. Students were taught in groups of three and received alternating sessions of one-on-one instruction and group instruction. Group instruction was provided sequentially and turns were evenly and randomly interspersed among students. Using a parallel treatment design embedded within a multiple baseline across skills, results indicated a functional relation between discrete trail instruction provided in group and one-on-one. No clear separation indicating efficiency of one instructional arrangement over another was identified; however, contrary to previous research, very little observational learning was demonstrated. The authors indicated that group instruction may be equally effective to one-on-one instruction and therefore could be used to provide instruction more efficiently in classroom settings.

Ledford and Wolery (2013) investigated the effects of progressive time delay implemented during small group instruction on identifying academic stimuli with three preschoolers with disabilities. Two of the preschoolers were diagnosed with ASD. Inclusion criteria were used and required that students were ages 3 to 6-years-old, had an identified disability, were able to imitate simple movements and single words, needed to learn to label academic stimuli, and did consistently share or say “thank you” to peers. The two students with ASD were ages 4 and 6-years-old, and both were described as exhibiting disruptive behaviors in the classroom setting. The authors indicated that one of the students with ASD required “wait” training prior to the group instruction intervention. The primary dependent measure was percent correct academic responses and the secondary measure was percent correct use of “thank you” and sharing. The skills observed in the secondary measure were not directly taught to the students with ASD, but were included as measures of observational learning. Peers were trained to model sharing and thanking during the intervention. Students were taught in groups of three. Groups included one student and two typically developing peers. Instruction involved sequential presentation of discrete trials interspersed evenly across students. Using a multiple-probe across academic behaviors design, results demonstrated improvement in academic skills for both students with ASD; however, the intervention with one student did not result in an immediate effect and required between four to 10 sessions before a change in skill level was demonstrated. The second student with ASD demonstrated change in trend and level following one session of intervention. The authors indicated students learned some of the other students' academic target skills and stated that this adds to the literature indicating students with disabilities do demonstrate observational learning during small group instruction. The students with ASD demonstrated some sharing behaviors, but limited "thanking" behaviors following intervention. One limitation to the student was that the authors did not describe the "wait" training procedures used with student who needed additional group participation instruction.

One study that did specifically address working with individuals with behaviors disruptive to group instruction was conducted by Tincani and Crozier (2008). In this study the authors compared the effects of brief wait-time versus extended wait-time on (a) number of responses per minute, (b) percent correct responses per session, (c) percent 5s intervals of disruption during brief 5 min LfL DI lessons. Two participants ages 6 and 7 years old were included in the study. Both students attended a private clinic for students with behavioral and learning disabilities and were nominated by the school's director as students who displayed disruptive behaviors during group instruction. Both students were identified as having mild to moderate language delays. One student did not have a formal diagnosis, but displayed problem behaviors including tantrums, aggression, and noncompliance. The other student was diagnosed with autism and engaged in non-compliance and excessive questioning. Students were provided two daily 5 min sessions of LfL. Prior to the initial session, the students were trained to respond in unison during a brief warm-up activity. Using an alternating treatments design, results indicated that both participants demonstrated a higher level of increased responding, a higher percentage of correct responding, and a lower percentage of intervals of disruptive behaviors under the brief wait-time condition. Breif wait-time was defined as a 1s pause following the teacher question or direction and extended wait-time was defined as a 4s pause under the same conditions. The authors indicated that disruptive behaviors were ignored during instruction unless the behavior posed potential harm to himself or others. When this occurred the teacher used a system of least to most prompting to redirect the offending student to display on-task behaviors.

Summary of group instruction. Results of studies comparing one-on-one instruction to group instruction indicate that both are effective in increasing skills with students with severe disabilities and ASD (Leaf et al., 2013; Reid & Favell, 1984). This suggests that given the need for instructional efficiency in public schools and increased teacher-to-student ratio, group instruction may not only be preferable, but is as effective and more feasible than on-one instruction for students with ASD. Leaf et al. (2013) stated that these results should assuage those who worry group instruction will not be effective in producing individualized improvements in skills for students with ASD.

Few of the studies discussed inclusion criteria for participants in group instruction, and of those that did, two indicated inclusion of students who demonstrated disruptive or aggressive behaviors (Ledford & Wolery, 2013; Tincani & Crozier, 2008). Ledford and Wolery (2013) stated a student required group participation training (i.e., "wait" training), but did not explicitly describe the training procedures. Tincani and Crozier (2008) included a student with ASD who demonstrated excessive questioning and noncompliance and used planned ignoring when disruptive behaviors were displayed. In their review of small group instruction studies using discrete trial teaching, Ledford et al. (2012) indicated the limited inclusion of students displaying problematic or disruptive behaviors warrants further research in this area to determine who should be included in small group instruction. Research should also include more explicit instruction on how to teach students who have previously been unsuccessful or not included in group instruction the skills to support successful inclusion in small group instruction arrangements. The majority of the studies reviewed used sequential group instruction. To date, the only identified studies to use unison group instruction with students with ASD are those previously described in the DI section of this chapter, Tincani and Crozier (2008) and Ganz and Flores (2009; which was not included in the previous DI section because the students were not taught reading or mathematics).

Applied Behavior Analysis

In 1938 Skinner wrote *The behavior of organisms* with the purpose of defining a scientific system of behavior analysis. While behavioral experimentation had occurred prior to this (e.g., Pavlov's theory of respondent conditioning), Skinner's work (1938) was seminal in defining behavior (i.e., "the movement of an organism or of its parts in a frame of reference provided by the organism itself or by various external objects or fields of force." p. 6) and introducing the concept of "operant conditioning" (i.e., increasing the likelihood of a behavior by presenting a reinforcing stimulus following the occurrence of the behavior). Fuller (1949) demonstrated the first application of the analysis of the behavior of organisms to a human. In fewer than four days, Fuller taught an individual believed incapable of learning to raise his arm. Ferster (1961) was the first to discuss the application of behavior analysis to individuals with autism. In his theoretical paper he posited that behaviors of individuals with autism were maintained by environmental reinforcers that could be manipulated to decrease problem behaviors and teach desired behaviors (It is important to note that while Ferster's position paper was helpful in applying behavior analysis to individuals with autism, the paper has received criticism for the false implication that behaviors of individuals with autism were maintained by inappropriate rearing by their parents). Baer, Wolf, and Risley (1968) differentiated between basic analysis of behavior and applied analysis of behavior by stating, "applied research is constrained to look at variables which can be effective in improving the behavior under study" (p.1). The authors explained that applied behavior analysis is singularly attributed to research that is (a) *applied*, behaviors selected for improvement are socially significant; (b) *behavioral*, individuals actions are identified, measurable; (c) *analytic*, evaluation of behavior change is experimental and variables are controlled in such a way to allow for determination of whether a functional relation exists between the behavior and the intervention; (d) *technological*, behaviors and selected interventions are described clearly and precisely such that a person naïve to the individual whose behavior is to be changed can immediately recognize the selected behavior and is able to replicate the intervention solely based on the description of the behaviors and procedures; (e) based on *conceptual systems*, the selected intervention is clearly derived from principles of behavior analysis; (f) *effective*, identified behaviors are demonstrably improved to a level of social significance; (g) *generality*, behavior change is demonstrated over time and in varying contexts. Cooper, Heron, and Heward (2007) succinctly define applied behavior analysis (ABA) as “a scientific approach for discovering environmental variables that reliably influence socially significant behavior and for developing a technology of behavior change that takes practical advantage of those discoveries” (p. 3).

Since the beginning of application of behavior analysis to individuals with autism by Ferster (1961) there have been numerous ABA studies investigating the effects of interventions on the behaviors of individuals with autism. Recently, ABA was identified as an evidenced based practice for students with ASD (Howard et al., 2009; Wong et al., 2014). The evidence base provides support to the Lovaas and Smith (1989) behavioral theory of ASD and authority to the suggestions based on previous behavior analytic research with students with ASD provided by Heflin and Alberto (2001). Lovaas and Smith (1989) proposed a behavioral theory of ASD based on the supposition that individuals with ASD could be taught behaviors using ABA and that ASD characteristics are not impermeable, but can be decreased or replaced with appropriate behaviors. They outline four tenets of the theory: first, behaviors of individuals with ASD can be changed; second, ASD does not consist of a central deficit, but multiple developmental delays which means that there cannot be one distinct “fix” for the disorder, but instead systematically produced changes through instruction addressing the delays; third, individuals with ASD can learn given proper supports; fourth, autism is not a single disease which can be pinpointed and cured, but is identified by the authors as “a mismatch between their nervous system and the environment" (p. 23) and can be addressed by systematically manipulating the environment to support skill acquisition.

Heflin and Alberto (2001) discussed the importance of establishing a behavioral classroom context that promotes active student engagement of students with ASD. They describe the characteristics of classroom environments that promote this engagement which include developing a supportive and systematic classroom environment. The authors describe a supportive classroom environment as including physical structure, temporal structure, visual or concretes systems, and a climate of reinforcement. Physical structure minimizes distractions, emphasizes salient stimuli, provides clear boundaries, and predictable routines within each area defined in the classroom. Temporal structure involves utilizing interval schedules of reinforcement to increase student participation in classroom activities, developing consistent daily schedules that offer a variety of highly preferred activities interspersed throughout the day, and utilizing visual schedules to support predictability and independence in following the classroom schedule. Visual or concrete systems act as an antecedent prompt to complete classroom activities and support understanding of what is expected for those with limited comprehension of language. Developing a climate of reinforcement involves identifying consequences established as reinforcing to the students with ASD, incorporating behavioral momentum by interspersing high probability task (e.g., tasks students with ASD are likely to complete) with low probability tasks (e.g., tasks students with ASD are less likely to complete), and providing explicit positive social reinforcement consistently to students throughout the day. The second component needed to establish a behavioral classroom context is by developing a systematic instructional environment (Heflin & Alberto, 2001). The authors indicate that this involves carefully designed instructional technology, instructional considerations, and generalization. Instructional technology involves the systematic application of learning by identifying antecedent strategies such as response prompting procedures and determining the format to teach the skill. Further instructional considerations are provided including developing task analyses for teaching skills, sequencing skills from easy to hard, collecting ongoing data and adjusting instruction based on results, and providing consistent instruction. The authors indicate that once students demonstrate mastery of a skill, students should be systematically taught generalization of the skill through providing antecedent variations such as variations of materials, contexts, instructors, and instructions given. Further, maintenance should be promoted through intermittent review of the skill over time.

Strategies for increasing active student participation. One area that warrants attention when teaching academics to students with ASD is identifying strategies to increase participation. At times it may be difficult to determine whether students with ASD display academic deficits due to inability to generalize, interfering stereotypic behaviors, inattention, or because of cognitive deficits that make the skills difficult to attain. In order to decrease these problematic behaviors, it is necessary to use strategies that increase student active participation, which in turn, will provide feedback to the teacher regarding students' academic abilities. In addition, any success in improving active participation needs to transfer beyond the training setting. The following review of literature includes research related to these specific factors.

Proximity fading. Engelmann (2006) suggests instructors should maintain a close proximity when teaching low performers, such as students with ASD, in order to increase participation. Conroy, Asmus, Ladwid, Sellers, and Valcante (2004) investigated the effects of adult proximity on engagement and problem behaviors of six elementary students with ASD who received instruction in the general education setting. The results of this descriptive study examining the relationship between proximity and rates of behavior indicated a significant positive correlation between engagement and proximity (i.e., the closer the adult was to the student the more likely the student was to be academically engaged). However, findings were not as strong regarding problem behaviors. For some students problem behaviors increased with adult proximity, while with others, problem behaviors decreased. The authors indicated that the effect of proximity on problem behaviors can vary according to individual students with ASD. Further investigation of the function of the problem behaviors is suggested to determine what impact adult proximity may have on problem behaviors.

Wilczynski, Fusilier, Dubard, and Elliott (2005) investigated the effects of adult proximity on the on-task behavior of a 15-year-old student with ASD in a self-contained setting. Using an ABAB reversal design, results indicated the further away the staff was to the student the more likely he was to exhibit on-task behaviors. The authors hypothesized that escape-maintained negative social reinforcement may have increased on-task behavior for this student. In other words, the student increased his on-task work behaviors to avoid social interaction with his teachers.

Finally, Conroy, Asmus, Boyd, Ladwig, and Sellers (2007) investigated the relationship between several classroom factors and disruptive behaviors of five elementary students ages 5 to 10-years-old with ASD in general education classrooms. Using a descriptive study employing rate calculations and lag sequential analysis, the authors assessed influence of adult directives, group work versus independent work, materials, activity type, and adult proximity on the disruptive behaviors of the students with ASD. Results indicated the majority of the students displayed disruptive behaviors during independent work. Overall, fewer disruptive behaviors were exhibited during group instruction. The presence of materials increased the likelihood of disruptive behaviors and academic activities resulted in higher disruptive behaviors. Results for adult proximity were mixed. For three of the students adult proximity correlated with decreased disruptive behaviors and for the remaining two students adult proximity was correlated with increased disruptive behaviors.

Escape from task demands. Engelmann (2006) suggested incorporating breaks into sessions. He suggested the number of breaks be positively correlated with the difficulty of the instruction (i.e., if the instruction is difficult for the student, introduce more frequent breaks). He identified two types of breaks: a brief (i.e., 30 s to 3 min) cessation of task demands or switching to an easier task (i.e., reducing task demands). There have been several studies investigating the former type of break. In the literature reviewed, these breaks are generally referred to as escape from task demands. Literature has investigated and described contingent (Charlop, Kurtz, & Casey, 1990; Reichle, Johnson, Monn, & Harris, 2010) and noncontingent escape (Butler & Luiselli, 2007; Gieger, Carr, & LeBlanc, 2010; Kodak, Miltenberger, & Romanuk, 2003), as well as the impact of density schedules of escape on targeted behaviors (Ingvarsson, Hanley, & Welter, 2009; Reed, Ringdahl, Wacker, Barretto, Andelman, 2005) of students with ASD.

Contingent escape. Charlop et al. (1990) investigated the effects of potential reinforcers, food or aberrant behaviors (i.e., stereotypy, echolalia, perseverative behavior), offered as contingent escape on the percent of correct task performance of 10 elementary age students with ASD. Using an alternating treatment design, results indicated students performed with highest accuracy on tasks during the session in which students were allowed to engage in aberrant behaviors. These results indicated students with ASD may prefer escape contingencies which allow them to engage in stereotypical behaviors while devoid of task demands. Future research should consider whether task breaks should be structured or unstructured. It may be more appropriate to offer a student a socially appropriate alternative to aberrant behaviors whenever possible. However, given the potential high level of automatic reinforcement, researchers may want to consider allowing noninterfering stereotypical or perseverative behaviors occur during breaks from task demands (Charlop et al., 1990).

Reichle et al. (2010) investigated the differential effects of generalized versus explicit cues as signals for delayed escape from activities as reinforcement on increased work completion and decreased challenging behaviors in two preschool boys with autism age 4-years-old. Both participants had comorbid moderate to severe intellectual disability. The authors conducted a functional analysis to confirm that escape from task demands was the function of their challenging behavior. The authors used an alternating treatment design with changing criterions to compare two interventions: generalized delay cues (e.g., “almost done” paired with a visual picture signaling “almost done”) and explicit delay cues (e.g., “just [number] more” or “just [number] more minutes” paired with number of work units to be completed or time timer displaying visual depiction of remaining time). Following completion of criterion amount of work, students were told “let’s take a break” and provided a two to three minute break accompanied by a preferred activity or item. Once the break was over students were told, “Ok, time to work.” Results indicated clear separation between explicit cue and general cue in favor of explicit cue resulting in greater level and trend demonstrating greater efficiency in the use of the explicit cue in increasing work completion and decreasing challenging behavior.

Noncontingent escape. Gieger et al. (2010) describe a treatment selection model for determining which treatments to use for escape-maintained problem behaviors. They explained that escape from instructional task demands is a common function of escape-maintained behavior. The authors defined noncontingent escape (NCE) as “the delivery of escape from instructional activities on a time-based schedule (e.g., fixed time, variable-time), regardless of the individual’s problem behavior” (Geiger et al. 2010, p. 26). Benefits of the use of noncontingent escape are that it simultaneously provides a functional reinforcer while reducing problem behavior; it is not contingent on the occurrence of problem behavior, which may result in preventing the problem behavior altogether if the NCE provides a sufficient level of escape; and it can be effective without the use of extinction which may be impractical or unethical with some problem behaviors.

Kodak et al. (2003) compared the effects of NCE versus differential negative reinforcement of other behavior (DNRO) on disruptive and compliant behaviors of two 4-year-old children with ASD. Using an alternating treatments design, results indicated both NCE and DNRO decreased problem behavior and increased compliance with both students. NCE resulted in a higher rate of reduction of problem behavior and increase of compliant behavior. Authors suggested that while compliance was not targeted, it may have increased because frequent breaks made compliance with the tasks less aversive, possibly due to the decreased effort required because of shorter time on task.

Butler and Luiselli (2007) investigated the effects of NCE plus fading task demands on problem behavior (i.e., self-injury, aggression, tantrums) of a 13-year-old girl with ASD. Using reversal design, results indicated NCE plus fading task demands decrease problem behavior and ultimately increased the rate of instruction. Task demands were faded and then gradually increased. The authors suggested the combination of NCE plus fading task demands and then reintroducing task demands may assist students with ASD in building stamina and tolerance during instruction.

The rate of escape from task demands has also been investigated in attempts to determine the most effective ratio of breaks to instruction (Ingvarsson et al., 2009; Reed et al., 2005). Reed et al. (2005) compared the effects of fixed-time NCE and differential negative reinforcement of alternative behavior (DNRA) on the problem behavior (i.e., destruction, noncompliance, aggression) of two boys ages 8 and 10-years-old. One boy was diagnosed with ASD and the other boy had multiple diagnosis including oppositional defiance disorder, attention deficit hyperactivity disorder, and intellectual disability. In addition, the authors investigated a dense versus lean fixed-time NCE schedule. Using a reversal design results indicated both fixed-time NCE and DNRA were effective in reducing problem behaviors in both boys. Dense fixed-time NCE resulted in variable compliance and reduced problem behavior whereas lean fixed-time NCE resulted in more stable and higher compliance, as well as reduced problem behavior. The authors indicated that lean fixed-time NCE may be a better strategy to increase compliance and maintain the rate of instruction while reducing problem behaviors.

Summary of increasing student participation research. Research indicates that proximity fading (Conroy et al., 2007; Conroy et al., 2004; Wilczynski et al., 2005) and escape from task demands (e.g., Butler & Luiselli, 2007; Reichle et al., 2010) may be an effective strategy for decreasing problematic behavior and increasing targeted behaviors of students with ASD. The majority of the studies reviewed investigated the interventions with elementary-age students with ASD (e.g., Conroy et al., 2007; Reed et al., 2005). The interventions were carried out as participants completed a variety of tasks including imitation (Rincover & Koegel, 1975), social interactions (Petursdottir et al., 2007), vocabulary (Charlop et al., 1990; Spencer & Higbee, 2012); and academic tasks (Butler & Luiselli, 2007; Conroy et al., 2007; Conroy et al., 2004; Kodak et al., 2003; Reed, et al., 2005; Reichle et al., 2010; Wilczynski et al., 2005). Only two studies were conducted during a group setting (Conroy et al., 2007; Petursdottir et al., 2007). Petursdottir et al. (2007) conducted the intervention in dyads and Conroy et al. (2007) observed the effects of adult proximity during group instruction with five participants. Future research should investigate a combination of proximity fading and escape from task demands on the academic participation and skill acquisition of students with ASD.

Summary of the Review of the Literature

The characteristics of autism, including cognitive deficits relating to joint attention, theory of mind, weak central coherence, and executive functioning impact students' ability to achieve in academics (e.g., Estes et al., 2011). Research on academic interventions for students with ASD is sparse and recent studies teaching reading and mathematics skills have been limited to answering comprehension questions and mathematics operations (i.e., addition, subtraction, multiplication, division; e.g., Wong et al., 2014; Muchetti, 2013; Whitby, 2013). In addition, the independent variables are varied, often complex, and applied in clinical settings. DI is a promising intervention recently applied to teaching students with autism that can be used to consistently teach skills across academic domains, using a simple, predictable format which is feasible to implement in school settings (Watkins et al., 2011). Studies investigating teaching reading and mathematics skills using DI have been successful in demonstrating skill acquisition by students with ASD (e.g., Thompson et al., 2012). One challenge to the use of DI is that the instruction typically occurs in a group setting and requires unison responding by participants. Research on teaching individuals with ASD in groups has typically delivered instruction via discrete trials sequentially to individual learners (Ledford et al., 2012). In addition, few group intervention studies with students with ASD have indicated that the participants demonstrated interfering behaviors such as aggression and/or disruption (Ledford et al., 2012). ABA has been used to support learners with interfering behaviors to participate in classroom instruction (e.g., Gieger et al., 2012). Two primary interventions identified in the research are the use of proximity fading and escape from task demands provided either contingently or noncontigently. Results of this literature summary indicate that there is a need to investigate feasible and efficient strategies easily applied to typical public school settings to teach students with ASD to participate in group instruction which requires unison responding (e.g., DI) used to teach academics to students with ASD.

CHAPTER 3: METHOD

The purpose of this study was to investigate the effects of proximity fading and task breaks on responding during small group Direct Instruction in mathematics with students with ASD and the extent to which students demonstrated academic accuracy and generalization of responding. This chapter will describe the research methods used to investigate the research questions by delineating the participants, setting, instrumentation, experimental design, procedures, method of data analysis, interrater reliability, and procedural fidelity.

Participants and Setting

Participants were four students in grades K-2 diagnosed with ASD and eligible for special education services under this diagnosis. The experimenter asked teachers to nominate students who were compliant during one-on-one instruction, but had demonstrated difficulty participating in small group settings. Parental consent (see Appendix A) was obtained for the nominated students, and once obtained, students were assessed by the experimenter to determine eligibility for participation in the study. To be eligible, students needed to miss four or fewer items on the 15-item Low Performer's Manual (Engelmann, 2006) placement test and demonstrate enough language comprehension to pass the CMC-A placement test by correctly answering eight of 11 items (Engelmann & Engelmann, 2012). Both of these tests require a minimum level of receptive and expressive communication skills such as answering yes/no questions about the function and features of items in a picture (e.g., “Is this a man?”, “Is he wearing both shoes?”, “Do you drink from an ice-cream cone?”), identifying common objects (e.g., “cup,” “shirt,” “ice-cream cone”), following simple directions requiring understanding prepositions (e.g., “put the spoon under the table”), and answering simple personal questions (e.g., “What is your name?”, “How old are you?”). Finally, students needed to demonstrate compliance with the experimenter during placement testing (i.e., < two verbal refusals or attempts to elope and no physical aggression). Following eligibility assessment, four students were identified as eligible participants for the study. Two nominated students did not meet eligibility criteria. One student missed more than four items on the Low Performers Manual placement test. The second student did not demonstrate compliance with the experimenter. See Table 2 for included participants’ demographic information.

Table 2: Participants’ demographic information

Student	Diagnosis	IQ	Ethnicity	Age	Grade
Brittany	Autism (ADOS-2 score 17)	47 (WNV)	Caucasian	7	2
Levi	Autism (ADOS-2 score 15), Chromosomal Abnormality	62 (SB)	Caucasian	6	K
Reagan	Autism (CARS score 30)	57 (BSID)	Caucasian	5	K
Carson	Autism (ADOS-2 score 13)	68 (WNV)	African American	6	1

Note. ADOS = Autism Diagnostic Observation Schedule 2nd Edition, CARS = Childhood Autism Rating Scale 2nd Edition; WNV = Weschler Nonverbal Scale of Ability; SB = Stanford Binet Intelligence Scales; BSID = Bayley Scales of Infant Development

Brittany. Brittany was a 7-yr-old Caucasian female in the 2nd grade. She was diagnosed with ASD, demonstrated an IQ of 47 on the Weschler Nonverbal Scale of Ability (Weschler, 2006), and 17 on the Autism Diagnostic Observation Schedule 2nd Edition (Rutter, Le Couteur, & Lord, 2003) obtained by the school psychologist.

Levi. Levi was a 6-yr-old Caucasian male repeating Kindergarten. He was diagnosed with ASD by the school IEP team and diagnosed with a rare chromosomal abnormality by his primary care physician. He demonstrated an IQ of 62 on the Stanford-Binet Intelligence Scales (Roid, 2003) and 15 on the Autism Diagnostic Observation Schedule 2nd Edition (Rutter, et al., 2003) obtained by the school psychologist.

Reagan. Reagan was a 5-yr-old Caucasian female in Kindergarten. She was Brittany's younger sibling. She was diagnosed with ASD, demonstrated an IQ of 57 on the Bayley Scales of Infant Development (Bayley, 1993), and 30 on the Childhood Autism Rating Scale 2nd Edition (Shoepler & Van Bourgondien, 2010) obtained by the school psychologist.

Carson. Carson was a 6-yr-old African American male in 1st grade. He was diagnosed with ASD, demonstrated an IQ of 68 on the Weschler Nonverbal Scale of Ability (Weschler, 2006), and a 13 on the Autism Diagnostic Observation Schedule 2nd Edition (Rutter, et al., 2003) .

The study occurred in a suburban school district in the southeastern United States. The district is the 9th largest in North Carolina. It consists of 55 schools, including 30 elementary and primary schools, 2 intermediate schools, 11 middle schools, and 10 high schools, 1 special needs school, and 1 alternate school. As of 2013 there were 31,775 total students preK-12 enrolled with <1% American Indian, <1% Hawaiian, Pacific Islander, 1.4% Asian, 3.8% Multiracial, 9.5% Hispanic, 20.3% African American, and 64.7% Caucasian. Twelve percent of students in the district were identified as students with disabilities. There were 308 students identified as having ASD.

The study took place in a small rural elementary school serving 143 students in grades K – 5 with 0% American Indian, 0% Hawaiian/Pacific Islander, 0% Asian, 2.9% Multiracial, 7.3% Hispanic, 1.5% African American, and 88.3% Caucasian. Twenty-one percent of the students enrolled were identified as students with disabilities and 3% had limited English proficiency. There were two kindergarten classrooms, one each of grades 1-5, and 4 classes for students with ASD. The school served as a “cluster” school serving students with ASD living in the eastern section of the county who were identified as requiring services in a self-contained setting based on their IEP team decision. Baseline, implementation, generalization, and maintenance occurred within a self-contained classroom which served students with ASD and intellectual disabilities who receive academic instruction based on alternate achievement standards. There were a total of five students in the classroom with one teacher and one paraprofessional. Four of the five students were participants and the other student was not eligible for the study.

During small group instruction with the four students with ASD, there was another student who was not a participant but received instruction elsewhere in the classroom. The purpose of this arrangement was to provide the intervention in a naturally occurring setting where students typically received instruction. Participants received instruction at a small u-shaped table. The table was positioned so that participants were facing a wall to minimize distractions during instruction. The experimenter was seated in front of the participants across from the table or desks. This was to simulate how a classroom teacher would provide instruction and be able to scan the classroom of remaining students.

Experimenter

The author was the experimenter and served as the primary interventionist and data collector. She was a third year doctoral student in special education at the University of North Carolina at Charlotte, holds a North Carolina Teachers License, Master’s

Degree in Special Education, National Board Certification: Exceptional Needs Specialist – Severe and Multiple Disabilities (5-21), and is a Board Certified Behavior Analyst. She was a classroom teacher of students with autism for six years and has over 15 years experience working with students with autism using the principles of applied behavior analysis to teach skills to students with autism. While a teacher, she received training and coaching in DI from school district DI trainers.

Second Observer, Training, and Interobserver Agreement

Interrater-reliability and procedural fidelity data were collected by a second doctoral student in special education. The second observer viewed videos and collected data for the dependent variables (see Appendix B) across all phases of the study. In addition, the second observer collected procedural fidelity of components of the intervention and implementation of the DI curricula (see Appendix C).

The second observer collected interobserver agreement (IOA) data for X% of sessions across all phases for each student (see Appendix B). The experimenter and second observer read and discussed operational definitions of group response behavior and practiced data collection procedures using video clips from a previous study of students demonstrating group response behaviors. Practice was considered complete when observers demonstrated 100% agreement on three 5 min video segments. Because trial-by-trial agreement was difficult to obtain due to the rapid pace of instruction, IOA for group responding and academic accuracy was compared using a gross method comparison (Cooper et al., 2007). Percent agreement for group responding was calculated by divided the smaller number of correct responses by the larger number of correct responses and multiplying by 100. The same procedure was used to determine percent agreement for academic accuracy.

Dependent Variables and Data Collection Procedures

Responding during small group instruction. Responding during small group instruction included responding to any directive that required a group response. The majority of group responses were choral responses (i.e., answering vocally in unison); however, some responses included “touch,” “point to,” “cross out,” “write,” etc. Group responding was counted correct if the student responded within 1s of the teacher’s signal. For example if the teacher said, “Ten. What’s the next number?” and signaled (i.e. snaps), the student would respond within 1s following the signal. If the response was incorrect, but occurred within a 1s latency, it was still counted as a correct group response. Group responding was graphed as percent correct for each participant.

Academic response. An academic response was a response elicited by an instructor’s signal that demonstrated a mathematic skill (during CMC instruction) or language skill (during Language for Learning [LfL] instruction). Data were collected on academic accuracy of participants’ group responding. For example, if the teacher said, “Ten. What’s the next number?” and the student responded “11” within 1s, the response was counted as a correct academic response. Written responses did not have to be neat to be counted correct if accurate; however, they had to be legible to both the experimenter and second observer. None of the students required assistive technology for writing (e.g. a keyboard or specialized grip); however, this would have been provided during the workbook portion of the lesson if needed. Response accuracy was graphed as percent correct for each participant.

Data collection procedures for responding and academic response. During daily CMC-A lessons, data on group responding and academic accuracy were collected individually for each student using event recording (see Appendix B). A video camera was set up behind the teacher so that all of the students could be seen looking at or responding to each instructional direction or question. The experimenter viewed a videotape of the instruction and recorded a correct or incorrect response for group responding for each individual student for every group instructional stimulus. If a student correctly responded, the observer also marked whether or not the response was accurate. If the response required creating a permanent product (i.e., written response), these products were assessed for accuracy, since the video did not provide enough detailed resolution to adequately observe the written response for each participant. Each session lasted for approximately 25 min. At the end of the session, percent correct for group response for each student was determined by calculating the number of correct group responses divided by the number of opportunities to respond multiplied by one hundred. The same procedure was used to determine the percent correct for academic accuracy.

Mathematics skills. Mathematics skills were measured proximally using the CMC-A cumulative test (Engelmann & Engelmann, 2012) and distally using ASPENS mathematics subtests “numeral identification,” “magnitude comparison,” and “missing number” (Cambium Learning Group, 2012). Both tests were administered to each student prior to baseline and following the last session group responding instruction. Mathematics skills are reported descriptively.

There are two CMC-A cumulative tests: one following lesson 60 and the other following lesson 120. CMC-A cumulative test one was used as the pre-post measure and was selected based on where the participants placement in the initial lesson of the program. The duration of the intervention did not include all the lessons assessed in the cumulative test, so it was not possible for participants to obtain a passing score on the test based on the limited instruction provided. The points on the test are disaggregated to assess the components taught during the intervention and participants' performance on those items.

ASPENS is a progress monitoring tool used to measure achievement and growth in early mathematics (Cambium Learning Group, 2012). The mathematics subtests "numeral identification," "magnitude comparison," and "missing number" measure number identification, quantity discrimination, and missing number identification. The duration of assessments were 1 min per subtest.

Data collection procedures for math skills. Assessments were administered individually to each participant. The experimenter administered the CMC-A (Engelmann & Engelmann, 2012) cumulative test and ASPENS mathematics subtests ""numeral identification," "magnitude comparison," and "missing number" (Cambium Learning Group, 2012) as described in the test administration instructions for the assessment. Scores are reported in a descriptive table listing students and their respective scores for the assessments.

Social Validity

Social validity information was obtained from special education teachers. Following the intervention, a brief questionnaire (see Appendix D) was provided to the teachers to obtain their opinion on (a) goals: Does the program match the IEP goals for your student?, (b) procedures: What is your opinion of the acceptability of the intervention?, and (c) outcomes: Would this improve the efficiency of your instruction? Were the student gains in group responding meaningful? Were the student gains in mathematics skills meaningful? There was be space for teachers to write additional comments.

Experimental Design

A multiple probe across students design (Gast, 2010; Horner & Baer, 1978) was used to determine the extent to which a functional relation existed between the intervention and students' group responding. The intervention was replicated across 2 additional students. The What Works Clearinghouse single-case standards (Kratochwill et al., 2013) were used to guide procedures. A minimum of four to five data points were taken in each phase of the study. Intervention decisions were made based on participants performance on responding during CMC-A (Engelmann & Engelmann, 2012) group instruction. First, baseline data were taken on group responding during CMC-A (2012) lessons. Once baseline data were stable for the participants, the intervention began with the first participant, Brittany, who demonstrated the lowest and most stable performance. During intervention, once an increase in trend and/or level in group responding was determined for a minimum of three data points based on visual analysis of the responding data, Levi began receiving the intervention. The same procedures were followed for Reagan. Participants would have stopped receiving intervention practice sessions once they had demonstrated three consecutive days of responding on 80% of opportunities or higher. However, no students demonstrated this level of responding. Therefore, once students entered the intervention they continued to receive practice sessions for the remaining duration of the study. Data would have been collected on responding by the participant for five sessions following cessation of the intervention had they reached the criterion of 80% correct responding. If a participant had reached the maintenance phase and responded less than 80% during three or more of the five sessions the participant would have been returned to intervention for a "booster" practice session. Participants continued to receive instruction and error correction on group responding throughout intervention, so it was anticipated that participants who initially made limited progress in group responding would continue to show improvement throughout the intervention. When improvement was not demonstrated, a decision was made to provide increased opportunities for reinforcement and modifications of the practice sessions with the participant. The experimenter conducted a visual analysis of the data to determine a functional relation using the six criteria (i.e., level, trend, variability, immediacy of effect, overlap, and consistence of data patterns across similar phases) identified by the What Works Clearinghouse Single Case Standards as "Criteria for Demonstrating Evidence of a Relation Between an Independent Variable and Outcome Variable" (Kratochwill et al., 2013, p.31).

Procedure

Placement tests and pretests. Prior to baseline, students who met inclusion criteria were assessed on performance on the CMC-A cumulative test(s) (Engelmann & Engelmann, 2012). First, CMC-A cumulative test 1 was administered. If a participant had scored 80% or higher on cumulative test 1, cumulative test 2 would have been administered. However, no participants demonstrated a high score on cumulative test 1. Participants were placed into a group of four based on their performance on the CMC-A cumulative test. The purpose of this was to ensure that the group was as homogenous in their mathematics skills as possible. Students were also given the ASPEN mathematics subtests “numeral identification,” “magnitude comparison,” and “missing number” (Cambium Learning Group, 2011) at that time. Each participant was administered the tests individually at work table in their classroom.

Baseline. Participants received CMC-A (Engelmann & Engelmann, 2012) instruction for a minimum of six sessions and were taught according to the script. One exception was the use of the stipulated signal, “everybody.” This signal was used prior to instructional information and/or an instructional stimulus and immediately following the instructional stimulus. The purpose of stating “everybody” prior to instructional information and/or an instructional stimulus was to gain participants’ attention. The purpose of stating “everybody” immediately following the instructional stimulus was to signal that all participants were to respond. If the experimenter intended for only one participant to respond, “everybody” was be replaced with the student’s name immediately following the instructional stimulus. See Table 3 for examples of using the stipulated signal, “everybody” during instruction.

Table 3: Example of stipulated signal use during CMC instruction

Original text in CMC-A*	Example of embedding stipulated signal in text
(Display page and point to rows.) **Some of these symbols are 9.** (Point to 3). **Is this 9?** (Touch.) *No*. **What is it?** (Touch.) *3*.	(Display page and point to rows.) **Everybody, some of these symbols are 9.** (Point to 3). **Is this 9? Everybody.** (Touch.) *No*. **Everybody, what is it? Everybody.** (Touch.) *3*.

Note. Text in parenthesis shows directions for the instructor to follow, bold text is what the instructor says, italicized text is the correct response that the participants should say. *selected from lesson 26 CMC-A (Engelmann & Engelmann, 2012, p.299)

Prior to each lesson, the experimenter reviewed a “star student” chart (see Appendix F) that listed rules for “star student” behavior including “sit up, track with your eyes, answer on signal, and respect others.” Potential reinforcers offered during instruction were those delineated in the lesson script (e.g., Teacher/Student game and verbal praise). In addition, praise contingent on correct group responding was provided. This praise consisted of intermittent "high fives" and a higher level of enthusiasm and amplitude than is typical during the scripted lesson. A noncontingent 1 min break was provided to students following 10 min of instruction. Each instructional session lasted 20 min, therefore two breaks per session were provided to participants. If a lesson was completed prior to the end of the 20 min session, the experimenter continued instruction with the next lesson until the end of 20 min. A chart with five time intervals (2 min per interval during group instruction) and a picture of whiteboard and markers after the last interval was displayed in view of the students (see Appendix G). A silent timer notified the researcher when to mark the chart (see Appendix H). After all five intervals were marked, students were provided a 1 min task break with access to markers and whiteboards. During the break the researcher reset the timer, erased the chart with the time intervals, and prepared any necessary materials for the next teaching interval.

In addition to the experimenter-planned procedures, the classroom teacher requested that her established behavior plan be continued with the students while participating in the math instruction. The behavior plan consisted of a response cost procedure wherein students were given a laminated card with three stars and reminded to be a "star student." If students were noncompliant, the teacher instructed the experimenter to remove a star and remind the student to behave like a "star student." If the student lost all three stars, the student was instructed to go to the area of the room where students lined up to transition which was marked with tape and each student's name to designate where they stood or sat while waiting for transitions. The student was directed to sit in their spot for 1 min and then return to the activity at which point all stars would be returned to the students' card. The experimenter provided an initial reminder to be a star student if a participant demonstrated noncompliance. Behaviors defined as noncompliant and incurring removal of a star included getting up from the table, climbing on or under the table, poking another student, shouting, or excessively interrupting during instruction. Only twice during the study did a participant, both times Levi, lose all three stars and was asked to leave instruction for 1 min before returning. The other participants lost one star total across all group instructional sessions, indicating that noncompliance was a rare occurrence during instructional sessions.

Once a stable baseline with a minimum of five data points was demonstrated for at least one participant, the first participant, Brittany, began receiving the intervention. During baseline if one or more students had demonstrated ≥ 80% accuracy in group responding, they would have been identified as not needing group responding intervention but would continue to receive CMC instruction during CMC sessions and would have been referred to as CMC peers (CMC-P). No students were identified during baseline as CMC-P during this study.

Proximity fading and task breaks. Intervention consisted of practice sessions provided immediately prior to CMC-A group instruction. During these practice sessions the participant received instruction using previously taught CMC-A lessons (e.g., lessons 1-5 from baseline). The experimenter used proximity fading and task breaks during the practice sessions. The steps of the intervention and their description are provided in Table 4. Figure 1 demonstrates close, midway, and normal teaching position.

Table 4: Group responding practice intervention steps and descriptions

Intervention Steps	Description	Reinforcement Schedule	Criterion to move to next step
Close proximity	CMC-A stimulus and experimenter approximately 9-12 inches from participant. Experimenter maintaining direct eye gaze with participant at all times. Verbal discriminative stimulus "everybody" used for each task.	CRF	3 consecutive correct responses
Midway proximity	CMC-A stimulus and experimenter approximately **24-36 inches from participant.** Experimenter maintaining direct eye gaze with participant at all times. Verbal discriminative stimulus "everybody" used for each task.	CRF	3 consecutive correct responses (≥ 3 consecutive incorrect responses return to previous step)
Normal Teaching position (NTP)	CMC-A stimulus and experimenter in normal teaching position approximately **48-60 inches from participant.** Experimenter maintaining direct eye gaze with participant at all times. Verbal discriminative stimulus "everybody" used for each task.	CRF faded to IR	10 consecutive correct responses (≥ 3 consecutive incorrect responses return to previous reinforcement schedule or step)
NTP + changing eye gaze	CMC-A stimulus and experimenter in normal teaching position approximately 48-60 inches from participant. **Experimenter varying eye gaze between participants and stimulus.** Verbal discriminative stimulus "everybody" used for each task.	CRF faded to IR	10 consecutive correct responses (≥ 3 consecutive incorrect responses return to previous reinforcement schedule or step)
Interspersal of Individual and group response	CMC-A stimulus and experimenter in normal teaching position approximately 48-60 inches from participant. Experimenter varying eye gaze between participants and stimulus. **Verbal discriminative stimulus varying between "everybody" and named individual.**	IR	10 consecutive correct responses (≥ 3 consecutive incorrect responses return to previous step)
Noncontingent Intervals	CMC-A stimulus and experimenter in normal teaching position approximately 48-60 inches from participant. Experimenter varying eye gaze between participants and stimulus. Verbal discriminative stimulus varying between "everybody" and named individual. **Five interval chart from CMC group instruction introduced with noncontingent break provided at the end of five intervals.**	5x30s = 2.5 min Increased to 5x1min = 5 min Increased to 5x2min = 10 min	4/5 intervals with 100% group responding then move to next interval (≥ 4 intervals with less than 100% group responding return to previous interval or step)

Note. CRF = continuous reinforcement: reinforcer delivered for each correct response; IR = intermittent reinforcement: reinforcer delivered after an intermittent number of correct responses.

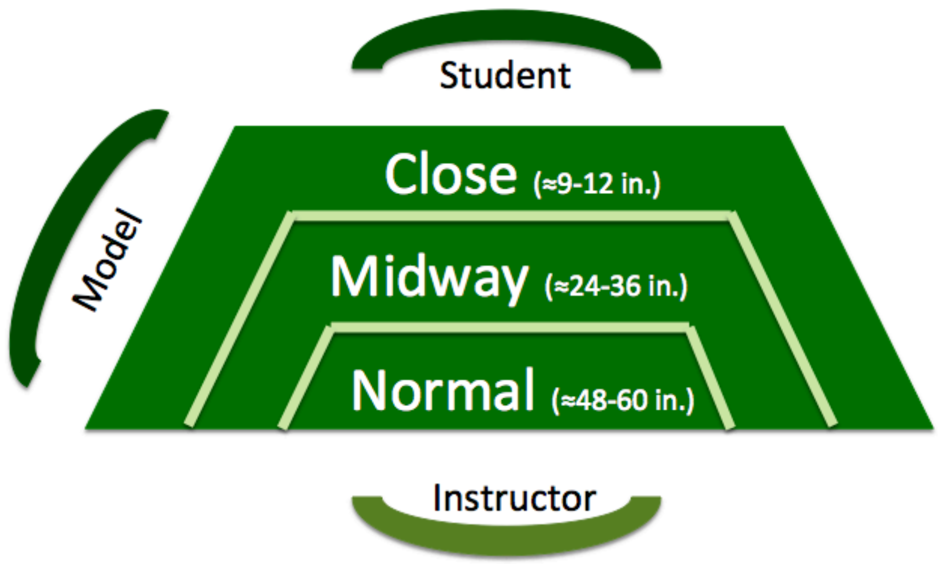


Figure 1: Demonstration of close, midway, and normal teaching position during practice sessions

Initially, task breaks were provided contingent on the participant providing a correct group response. The contingent task breaks lasted 20 s. Once the participant demonstrated 10 consecutive group and individual correct responses at the normal teaching position, the time interval chart used during group instruction was introduced to the participant. Breaks were provided on increasing intervals (i.e., five 30 s intervals with break every 2.5 min, then five 1 min intervals with break every 5 min, and, finally, five 2 min intervals with break every 10 min) until the participant received breaks at the same ratio as during CMC group instruction. The purpose was to provide the participant with a break from task demands. During the break the participant was given a dry erase board and marker. This item was selected as a potential common reinforcer; however, students were not required to use it if they chose not to.

Intervention practice sessions lasted 10 min. At the end of the practice session the experimenter stated, “Remember to look and answer just like we practiced.” Following the practice session, the participant was told to check his/her schedule or return to the teacher led morning meeting if it was still occurring while the experimenter set up for the CMC group lesson. When more than one student was receiving practice sessions, the order of practice sessions were counterbalanced such that participants were the first to receive a practice session on one day, the second or third on the following day, etc. This meant that the interval following the practice session prior to entering group instruction was between 5 min and 40 min, which included time for transition and for the experimenter to prepare materials for the subsequent participants. Once the experimenter was ready, participants were directed to the table to begin the lesson. CMC lessons included four participants. Immediately prior to beginning the lesson, the experimenter stated to the participant(s) who received a practice session, “Remember, look and answer just like we practiced earlier.”

Probe data were collected from the CMC lesson on group responding for all participants. Once the first participant in intervention, Brittany, demonstrated an increase in level for group responding and five data points were collected, the next participant, Levi, began receiving the group responding practice sessions. Practice sessions continued for all participants throughout the duration of the study. If a participant had demonstrated ≥ 80% accuracy in group responding during CMC lessons the experimenter would have ceased providing practice sessions to that participant. Participants did not participate in practice sessions together. That is, each participant received practice sessions separately from one another. If more than one student was receiving the intervention, the participants’ sessions were alternated (e.g., on day one participant A’s session, then participant B's session, then group instruction; day two participant B's session then participant A's session then group instruction).

Two students received alterations to their practice sessions due to minimal or decreasing responding during intervention. Levi demonstrated minimally increased responding following intervention. Following the fourth practice session, the experimenter introduced high interest materials identified by the classroom teacher as reinforcing to Levi. Prior to instruction during the practice session, Levi was shown a laminate choice board (see Appendix J) and asked "what do you want to work for?" Once Levi pointed to his choice a visual reminder was placed on the table in front of him that said, "I am working for" and had a picture of his selected item (see Appendix K). In addition, the CMC-A math presentation book was altered with line drawings of high interest items taped over line drawings provided in the text. For example, the presentation book originally displayed a pattern of a man, a dog, and a woman. The experimenter altered the presentation book to display a pattern of a man, a dog, and Spiderman (see Appendix L). Brittany continued to decrease in responding over time and the experimenter hypothesized that this may be due to lack of stamina to endure the long instructional sessions. Therefore, the experimenter began providing practice sessions to Brittany following a break after the group instructional session.

Maintenance and generalization. Maintenance probes were not collected due to participants' not reaching criteria of ≥ 80% accuracy in group responding and therefore not ceasing practice sessions. Generalization probes on group responding and academic accuracy were collected once during baseline and intervention using 20 min group instruction sessions teaching Language for Learning (L4L; Engelmann & Osborne, 2008). The same procedures were used during LFL as were used during group instruction with CMC-A (e.g., noncontingent break following 10 min, high fives for group responding, use of stipulated "everybody" signal, etc.)

Procedural fidelity. The second observer observed 20% of the practice sessions and whole group instruction sessions distributed across each phase of the study to assess procedural fidelity. For the DI curricula, a fidelity observation form (see https://www.mheonline.com/assets/pdf/CMCLearnMore/Technology/cmc_fidelity_observation_form.pdf) was used by the second observer to measure (a) set up and management of instruction, (b) mathematics exercises, (c) error corrections, (d) workbook instruction, and (e) data management. In addition, a brief checklist (see Appendix B) of the additional components (e.g., amplified verbal praise for group responding, stipulated signal "everybody") included during group instruction was used. The practice sessions were measured using a checklist (see Appendix I) for implementation of each of the steps of the intervention. Procedural fidelity was reported as percent correct and calculated by the number of correctly completed steps or components divided by the total number of steps or components multiplied by one hundred.

CHAPTER 4: RESULTS

This chapter presents the results of the study. First, interobserver agreement (IOA) and procedural reliability will be reported. Next, the results for each research question will be presented.

Interobserver Agreement

A trained second observer scored 24% (n=6) of all group instructional lessons (n=25) across phases. For each group instructional lesson, group responding and academic responding were scored. Specifically, each lesson yielded eight IOA scores: (a) percent correct group responding for each of the four participants and (b) percent correct academic responding for each of the four participants. Overall, IOA on percent correct group responding ranged from 71% to 100% with a mean of 87%. Overall, IOA on percent correct academic responding ranged from 75% to 100% with a mean of 88%. Across participants, IOA data were collected across 30% of baseline with a percent correct group responding ranged from 71% to 100% with a mean of 86% and a percent correct academic responding ranged from 80% to 100% with a mean of 87%. IOA data were collected across 24% of proximity fading and task breaks intervention with a percent correct group responding ranged from 75% to 97% with a mean of 88% and a percent correct academic responding ranged from 75% to 95% with a mean of 89%. Percent of correct group responding IOA data are reported for individual participants in

Table 5 below. Percent of correct academic responding IOA data are reported for individual participants in Table 6 below.

Table 5: IOA for group responding across participants and conditions

	Conditions		Overall IOA	
	Baseline	Intervention		
Participant	Mean	Mean	Mean	Range
Brittany	80	94	87	73-97
Levi	84	83	83	71-97
Reagan	94	88	91	85-100
Carson	85	X	85	75-93

Table 6: IOA for academic responding across participants and conditions

	Conditions		Overall IOA	
	Baseline	Intervention		
Participant	Mean	Mean	Mean	Range
Brittany	90	84	87	75-100
Levi	86	92	89	81-95
Reagan	92	90	91	87-98
Carson	86	X	86	80-93

The majority of disagreements between the experimenter and the second data collector were related to intelligibility of student utterances. In addition, two of the students made minimal lip movement when they spoke and it was often difficult to discern who responded when watching the video recording. The experimenter was more familiar with the students and their voices as was better able to discern who responded based on their voice whereas the second observer was at a disadvantage with only observing the students via video viewing. This may be a function of using video equipment as opposed to live observations.

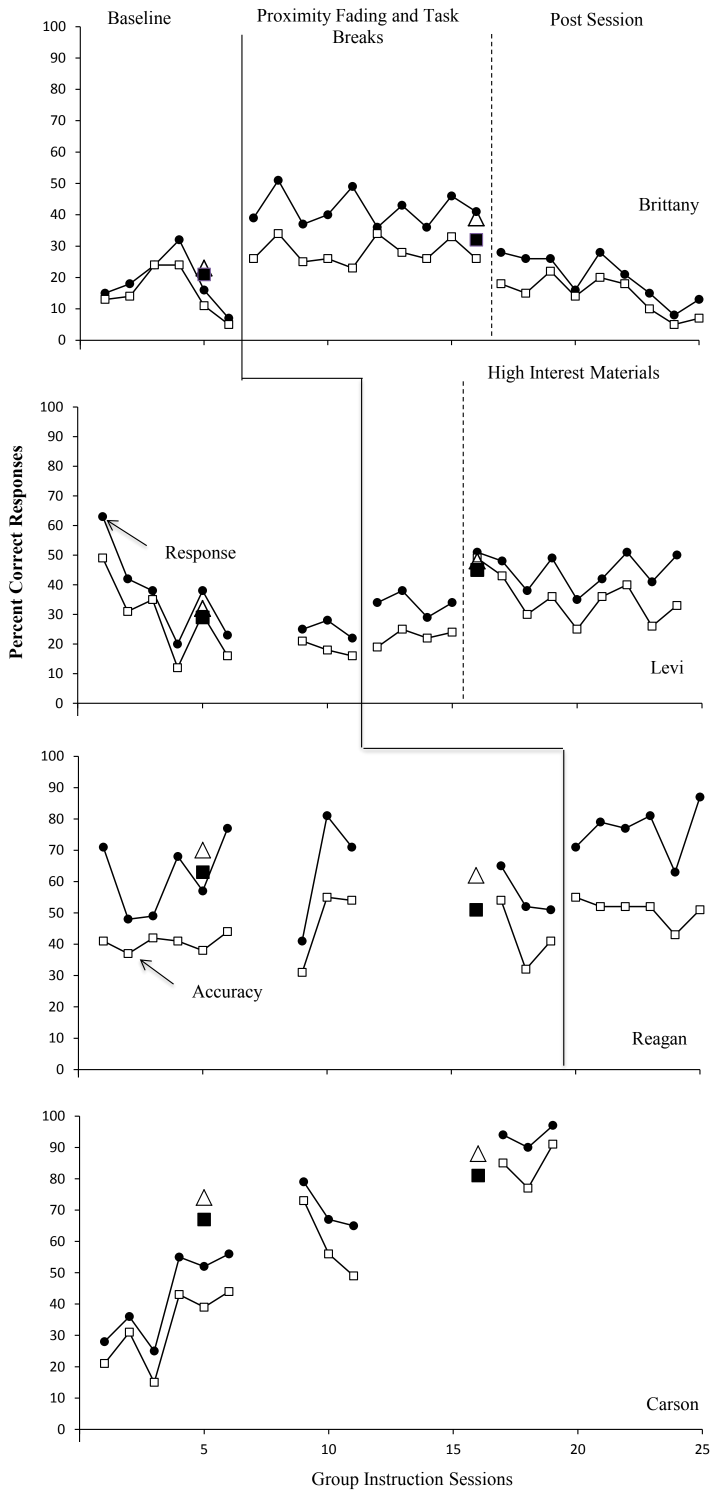
Procedural Reliability

To ensure the practice sessions and group instructional sessions were implemented as designed and with fidelity, the second observer watched videos of the practice sessions and group instructional sessions. Procedural reliability was assessed for the practice sessions using a checklist to mark whether the components of the implementation steps for proximity fading and task breaks were met or not met (see Appendix I). Procedural reliability of the group instruction sessions was assessed using the group instruction fidelity checklist (see Appendix C) and the CMC fidelity observation form (see https://www.mheonline.com/assets/pdf/CMCLearnMore/Technology/cmc_fidelity_observation_form.pdf). Procedural reliability was conducted across 24% of the practice sessions and group instructional sessions. Overall mean procedural reliability was 97% with a range of 95% to 100%.

Research Question 1: What are the Effects of Proximity Fading and Task Breaks on the Number of Responses During Small Group Direct Instruction in Mathematics for Students with Autism?

Results showing the effects of proximity fading and task breaks on the number of responses during small group DI in mathematics are shown in Figure 2. The graph shows participants' results of percent correct group responding across group instruction baseline and during practice session intervention utilizing proximity fading and task breaks. Based on a visual analysis of the data analyzing the six outcome measures suggested by Kratochwill et al. (2013): (a) level, (b) trend, (c) variability, (d) immediacy of effect, (e) overlap, and (f) consistency of data patterns across similar phases a functional relation between proximity fading and task break and group responding could not be established. Three participants were included in the multiple probe across participants but did not result in three demonstrations of effect. Only one participant demonstrated consistent low levels of behavior. One participant, Carson, did not receive the intervention due to an increasing baseline trend ultimately resulting in meeting criterion levels without additional supports (see Figure 2 below). A trend was difficult to establish for Reagan due to variability and Levi initially demonstrated high levels of responding but then displayed a decreasing trend. During proximity and task break phase, Levi and Reagan displayed a stable trend. However, Brittany displayed a decreasing trend resulting in near zero levels of responding. Variability was high during baseline with Levi and Reagan. Although variability did decrease during the proximity fading and task break phase, there was minimal immediacy of effect across all three participants. All three participants who received intervention displayed high levels of overlap from baseline to proximity and task break phase. Finally, behaviors were marginally more consistent during the intervention phase with less variability and a more stable trend for all three participants.

Brittany. Brittany's baseline was low with slight variability and no trend. Her scores ranged from 7% group response accuracy to 32% accuracy. Her baseline mean was 19% accuracy. Once proximity fading and task breaks were introduced there was an increase in group responding to a modest level. Scores were fairly stable with no trend. During this phase Brittany's scores ranged from 36% accuracy to 51% accuracy with a mean of 42% accuracy. The experimenter hypothesized that the low level of participation may have been due to limited stamina for group participation. As such, the experimenter began providing post-session proximity fading and task breaks after a 10 min break following the group instruction session. Following this change Brittany's scores decreased and demonstrated a stable decreasing trend. Her group responding accuracy ranged from 8% accuracy to 28% accuracy with a mean of 20% accuracy.



Note. Open triangles = generalization probes of group responding during LfL group instruction; closed squares = generalization probes of academic accuracy during LfL group instruction.

Figure 2: Participants' percent correct responding

Levi. Levi's baseline data were variable with a decreasing trend. His group responding accuracy ranged from 20% accuracy to 63% accuracy with a mean of 33% accuracy. Once proximity fading and task breaks were introduced, Levi demonstrated a very small increase in group responding accuracy compared to the last three data points prior to introduction of the intervention. However, accuracy was still much lower that initial group responding during baseline. During this phase Levi's group responding accuracy ranged from 29% accuracy to 38% accuracy with a mean of 34% accuracy. The experimenter hypothesized that Levi might respond to high interest materials. Following four sessions of proximity fading and task breaks, the experimenter introduced high interest materials and item choices for task breaks. After introduction of high interest materials and choices, Levi demonstrated a modest increase group responding accuracy with somewhat variable accuracy and no discernable trend. During this final phase, Levi's group responding accuracy ranged from 35% accuracy to 51% accuracy with a mean of 45% accuracy.

Reagan. Reagan's baseline data were highly variable with no discernable trend. Her group responding accuracy ranged from 41% accuracy to 81% accuracy with a mean of 61% accuracy. Following proximity fading and task breaks intervention, Reagan's scores became more stable with an increasing trend. Her group responding accuracy scores ranged from 63% accuracy to 87% accuracy with a mean of 76% accuracy.

Carson. Carson's baseline data demonstrated a slightly variable increasing trend during baseline. His group responding accuracy scores ranged from 28% accuracy to 97% accuracy with a mean of 64%. Due to Carson's continuous increase in group responding accuracy leading to group responding criterion, he was not provided with proximity fading and task breaks (see Figure 2).

Research Question 2: To What Extent Do Students Demonstrate Academic Response Accuracy When Responding During Small Group Direct Instruction in Mathematics?

Results showing the effects of proximity fading and task breaks on the number of academic responses during small group DI in mathematics are shown in Figure 2. The graph shows participants' results of percent correct academic responses across group instruction baseline and during practice session intervention utilizing proximity fading and task breaks. Overall, academic response accuracy was lower than group response accuracy for all participants. Based on a visual analysis of the data a functional relation between proximity fading and task break and academic response accuracy could not be established. Phase change decisions were made based on group responding. However, correct academic responding demonstrated similar results. As with group responding, only one participant demonstrated consistent low levels of academic responding. Again, Carson did not receive the intervention due to an increasing baseline trend ultimately resulting in meeting criterion levels without additional supports (see Figure 2). Brittany and Reagan did not demonstrate a trend and Levi showed a decreasing trend during baseline. No trend was shown by any of the participants in the intervention phases. However, Brittany displayed a decreasing trend resulting in near zero levels of correct academic response following implementation of post-session intervention. Variability was high during baseline with Levi and moderate with Reagan during baseline. While variability did decrease during the proximity fading and task break phase, there was minimal immediacy of effect across all three participants. All three participants who received intervention displayed high levels of overlap from baseline to proximity and task break phase. Finally, as with group responding, academic accuracy behaviors were marginally more consistent during the intervention phase with less variability and a more stable trend for all three participants.

Brittany. Brittany's baseline was low with slight variability and no trend. Her scores ranged from 5% academic response accuracy to 24% accuracy. Her baseline mean was 15% accuracy. Once proximity fading and task breaks were introduced there was a very small increase in accurate academic responding. Scores were stable with no trend. During this phase Brittany's scores ranged from 23% accuracy to 34% accuracy with a mean of 28% accuracy. During the post-session proximity fading and task breaks phase change Brittany's scores decreased and demonstrated a decreasing trend. Her academic response accuracy ranged from 5% accuracy to 22% accuracy with a mean of 14% accuracy.

Levi. Levi's academic response accuracy baseline data were also variable with a decreasing trend. His academic response accuracy ranged from 12% accuracy to 49% accuracy with a mean of 25% accuracy. Once proximity fading and task breaks were introduced, Levi demonstrated no increase in academic response accuracy compared to the last three data points prior to introduction of the intervention. During this phase Levi's academic response accuracy ranged from 19% accuracy to 25% accuracy with a mean of 23% accuracy. During the phase introducing high interest materials, Levi demonstrated a slight increase in academic response accuracy, which ranged from 25% accuracy to 49% accuracy with a mean of 35% accuracy.

Reagan. Reagan's baseline data were somewhat variable with no discernable trend. Her academic response accuracy ranged from 31% accuracy to 55% accuracy with a mean of 43% accuracy. Following proximity fading and task breaks intervention, Reagan's scores became stable with no trend. Her academic response accuracy scores ranged from 43% accuracy to 55% accuracy with a mean of 51% accuracy.

Carson. Carson's baseline data demonstrated a slightly variable increasing trend. His academic response accuracy scores ranged from 15% accuracy to 91% accuracy with a mean of 54% (see Figure 2).

Research Question 3: What are the Effects of Direct Instruction on Mathematics Skills of Students with Autism?

Table 6 summarizes the participants' pretest and posttest scores on the CMC-A cumulative test and ASPENS benchmark assessment. Percentage correct is reported from the CMC-A cumulative test 1. Up to 200 points can be awarded for correct answers on this assessment. However, based on the participants' progress made in the curriculum the number of possible points available on the skills actually taught was 51. The scores in Table 6 represent the percent correct out of 51 points. All students demonstrated an increase in performance on the CMC-A cumulative test. Composite scores are reported for the ASPENS benchmark assessment. Table 6 displays the composite scores and performance category demonstrated by the participants. There are three possible performance categories: benchmark, strategic, and intensive. Placement in the benchmark category indicates students are likely to end at or above grade level. Strategic performance indicates the students have approximately a 50/50 chance of performing at grade level at the end of the year. Intensive performance indicates the student is unlikely to perform at grade level at the end of the year. It should be noted that this benchmark assessment was based on Kindergarten performance. At the time of the study, only Reagan and Levi were in kindergarten. Brittany was in 2nd grade and Cameron was in 1st grade. Therefore, predictions cannot be made on achieving grade level for these two participants. In fact, their scores indicate performance well below grade level. Levi, Reagan, and Carson demonstrated improved scores from pretest to posttest and moved from the intensive category to the strategic category. Brittany's performance decreased slightly and remained in the intensive category.

Table 7: Participants' pre- and post scores on CMC-A cumulative test 1 and ASPENS benchmark assessment

	CMC-A Cumulative Test 1		ASPENS Benchmark Assessment	
Participant	Pre	Post	Pre	Post
Brittany	0%	12%	15.6 (Intensive)	14.9 (Intensive)
Levi	0%	35%	13.8 (Intensive)	26.2 (Strategic)
Reagan	18%	29%	3.4 (Intensive)	21.7 (Strategic)
Carson	29%	82%	15.5 (Intensive)	44.1 (Strategic)

Research Question 4: To What Extent Do Students Generalize Responding During Small Group Direct Instruction in Language?

Language for Learning was implemented twice during the course of the study. Group responding during LfL lessons was measured for Brittany and Levi during baseline and intervention. Reagan and Carson received both LfL lessons during baseline. Brittany demonstrated 23% group responding accuracy during baseline and 35% group responding accuracy during proximity fading and task breaks phase. Levi demonstrated 32% group responding accuracy during baseline and 48% group responding accuracy during proximity fading and task breaks phase. Reagan demonstrated 70% group responding accuracy during the first baseline measure and 62% group responding accuracy during the second baseline measure. Carson demonstrated 74% group responding accuracy during the first baseline measure and 88% group responding accuracy during the second baseline measure. See Figure 2 to see a graphical representation of the group responding generalization measures. Generalization data are represented by the open triangles.

Research Question 5: To What Extent Do Students Generalize Academic Response Accuracy When Responding During Small Group Direct Instruction in Language?

Academic response accuracy during LfL lessons was measured for Brittany and Levi during baseline and intervention. Reagan and Carson received both LfL lessons during baseline. Brittany demonstrated 21% academic response accuracy during baseline and 32% academic response accuracy during proximity fading and task breaks phase. Levi demonstrated 29% academic response accuracy during baseline and 45% academic response accuracy during proximity fading and task breaks phase. Reagan demonstrated 63% academic response accuracy during the first baseline measure and 51% academic response during the second baseline measure. Carson demonstrated 67% academic response accuracy during the first baseline measure and 82% academic response accuracy during the second baseline measure. See Figure 2 to see a graphical representation of the academic response accuracy generalization measures. Generalization data are represented by the closed diamonds.

Research Question 6: What are Teachers' Perceptions of the Acceptability and Feasibility of the Intervention?

A social validity questionnaire was given to the classroom teacher and speech language pathologist, who were regularly present in the classroom during implementation of the study. The questionnaire consisted of six Likert statements and a section for additional comments or suggestions. The Likert scale included “strongly disagree,” “disagree,” “agree,” and “strongly agree.” Both the teacher and the speech language pathologist rated “strongly agree” for the following statements pertaining to the proximity fading and task breaks intervention: (a) I feel that this intervention matched the students’ goals for group participation, (b) The intervention is feasible to implement, (c) I would use this intervention to teach my students group participation skills in the future, (d) I believe this intervention would improve the efficiency of my instruction, and (e) The students learned meaningful group participation skills. The teacher and the speech language pathologist rated “disagree” for the statement: The students learned meaningful mathematic skills. The classroom teacher wrote the following in the additional comments/suggestions section:

> “Curriculum script had too many words and a very rapid pace, which I think may have become overwhelming for students to process. Intervention worked very well to increase group participation and joint attention. I think students’ group responding and participation skills would have shown more growth had the curriculum material been ‘mastered’ academics at first so that only the group responding and participation piece would have been a new skill.”

The speech language pathologist wrote the following in the additional comments/suggestions section:

"I felt that the students' abilities to participate in group activities definitely improved. Their joint attention and understanding of choral responses improved with the use of 'everybody.' I'm very concerned about the pace of the program and significant amount of language that is used. Many of these students require very simplified 3 – 4 word phrases to understand what the teacher is saying, as well as wait time to process the receptive language. When there is too much language at a fast pace, the students do not learn the material. Their behavior improves with sitting and participating in a group, but it's difficult to determine how much they really understand."

CHAPTER 5: DISCUSSION

This chapter will discuss the results of research questions. In addition, contributions of the research to the literature, limitations of the study, future research suggestions, and implications for practice will be shared.

Research Question 1: What are the Effects of Proximity Fading and Task Breaks on the Number of Responses During Small Group Direct Instruction in Mathematics for Students with Autism?

Previous research on group instruction with students with disabilities indicates that few studies have investigated providing group instruction to students who demonstrate interfering behaviors (Ledford et al., 2012). Research using group instruction specifically with participants with ASD is limited and have typically used sequential group instruction. Two studies discussed the need for additional training to support group instruction (Ledford & Wolery, 2013; Tincani & Crozier, 2008). Ledford and Wolery (2013) provided “wait” training to one participant to improve successful group participation but did not describe the procedures used during this training. Tincani and Crozier (2008) compared brief versus extend wait time during LfL instruction on two students’ performance; however, the sessions were very short (5 min) and did not provide students’ the opportunity to complete a full DI lesson. The current study sought to investigate ways to support successful group responding for four participants with autism and mild to moderate intellectual disability who have previously not successfully participated in small group instruction. Results did not indicate a functional relation between proximity fading and task breaks on the number of responses during small group DI. Data stabilized and demonstrated a small increase in responding compared to the proximal baseline probes just prior to intervention. Due to the variable data in baseline, the data trend and mean line in the intervention phase were minimally different from baseline and did not produce a sufficient effect. This contradicts previous research by Thompson, Wood, and Preston (in preparation) in which a functional relation was identified between proximity fading and task breaks on the number of responses during small group DI.

There are, however, a number of differences between the two experiments. First, the current study included participant ages 5-yrs-old, 6-yrs-old (n=2), and 7-yrs-old. The participants in Thompson et al. (in preparation) were 7yrs (n=2) and 9 yrs old. It is possible participants in the previous study had acquired more school readiness skills (e.g., self-regulation strategies, persistence with difficult tasks, early literacy skills, conceptual knowledge including reasoning and problem solving) which contributed to their success in acquiring group responding skills. Second, there were differences in IQ between the current study (i.e. IQs = 47, 57, 63) and the prior study (IQs = 61, 67, 93) which may have impacted participants' performance. That is not to say that students identified with lower IQs may not be able to acquire group responding skills, but that skill acquisition may be acquired at a different rate of learning or may require a more intensive intervention approach. Third, a peer who demonstrated high levels of group responding was used in the previous study but not in the current study. However, the fourth participant, Carson, in the current study who was not provided intervention due to a continuously increasing trend line was performing at a peer modeling level (i.e., ≥ 80%) prior to the second participant, Levi, entering into the intervention and no change in level was noted for any of the participants. Fourth, participants in the prior study scored much higher on CMC-A math pre-test scores (86%, 69%, and 55%) than the current study participants (0%, 0%, 18%). In fact, this may be the most salient difference impacting group responding scores. The students in the Thompson et al. (in preparation) investigation entered the program with prerequisite skills rendering the initial lessons in CMC-A, which covered the skills students performed accurately on in the pre-tests, review sessions whereas the students in the current study had not acquired the skills taught in the initial CMC-A lessons and were at the acquisition stage of learning these skills. This meant that the students in the current study were acquiring both new mathematics skills and group learning behaviors compared the students in Thompson et al. (in preparation) whose skill acquisition was primarily limited to group learning behaviors. This suggests that practice in group responding skills for students with ASD may be more effective with familiar or mastered material.

Research Question 2: To What Extent Do Students Demonstrate Academic Response Accuracy When Responding During Small Group Direct Instruction in Mathematics?

Engelmann (1999) described four criterion for determining student-program alignment based on student responding during instruction. First, students should demonstrate 70% accuracy on initial introduction of concepts. Second, students should demonstrate 90% accuracy on previously introduced concepts. Third, by the end of the lesson, students should demonstrate 100% accuracy on all concepts presented during the lesson. Fourth, students' error rate should not greatly lengthen the duration of the lesson due to necessary error correction. During baseline, while percentage of group responding was variable, average academic accuracy of total group responses was 70% for Reagan, 75% for Levi, 79% for Brittany, and 81% for Carson (Note: these data are calculated by dividing the total number of accurate responses by the total number of group responses for each session and determining an average of academic accuracy per group response of all sessions. This is different from the data presented in Figure 2, which demonstrates the percent correct academic responses out of total opportunities to respond). During intervention, average academic accuracy of total group responses was 66% for Reagan, 74% for Levi, and 69% for Brittany (Carson remained in baseline due to meeting group responding criteria without need for intervention). Thus, in this study when students increased the number of active group responses during a session their accuracy decreased somewhat. Based on Engelmann's criteria (1999) the level of responding in both baseline and intervention indicate that students likely did not have the prerequisite skills needed to be successful. Engelmann indicated that when students perform below the aforementioned criteria they should be placed in an earlier portion of the program. In this instance, this is problematic given that the students began at the initial lesson in the program and after 25 sessions had only progressed to lesson 14. Several of the initial lessons have optional mirrored repeat lessons that can be used if the students were not firm during the first presentation of the lesson. Repetitions of lessons were required in all instances with this group of participants. In addition to limited prerequisite skills, it is also possible that accuracy was impacted by the task demands required by group responding which demand a high level of attending and verbal responding, skills that are typically deficits for individuals with ASD.

Research Question 3: What are the Effects of Direct Instruction on Mathematic Skills of Students with Autism?

The most promising results of this study were the increased math skills demonstrated by all participants. These results support the previous DI math study by Thompson et al. (2012), which demonstrated a functional relation between DI math lessons and ability to tell time on an analog clock. In the current study, all participants demonstrated improved scores on the CMC-A cumulative test. Participants increased between 11% and 53% with mean improvement of 27%. On the distal measure, ASPENS, 3 of the 4 participants demonstrated improved scores. All three of the participants who improved moved from strategic performance indicating minimal likelihood of demonstrating end-of-year kindergarten benchmarks to strategic performance indicating a 50-50 chance of demonstrating end-of-year kindergarten benchmarks. While these gains are modest, they were achieved with the equivalent of five weeks of instruction 20 – 30 min/day (duration up to 30 min depended on whether or not students were receiving pre-session training). The student who did not demonstrate improvement on the distal measure may have been demonstrating regression to the mean effect, wherein an individual previously performed at his/her highest skill level and performance is slightly reduced following retesting.

Questions 4 and 5: To What Extent Do Students Generalize Responding During Small Group Direct Instruction in Language? To What Extent Do Students Generalize Academic Response Accuracy When Responding During Small Group Direct Instruction in Language?

Visual analysis of the data indicates students performed similarly during LfL lessons to their performance in CMC-A lessons in both baseline and intervention on percentage of group responses. Percentage correct academic responses compared to total number of responses were also similar to CMC-A performance. There were differences in percentage academic accuracy of total group responses. In LfL during baseline, average academic accuracy of total group responses was 86% for Reagan, 90% for Levi, 91% for Brittany, and 91% for Carson. During intervention, average academic accuracy of total group responses was 93% for Levi and 82% for Brittany (Reagan and Carson had not been placed in intervention at this point). According to Engelmann's criteria (1999), the initial lessons of LfL appears to be a suitable program placement for group instruction for these participants based on their academic accuracy.

Question 6: What Are Teachers' Perceptions of the Acceptability and Feasibility of the Intervention?

According to the questionnaires, the teacher and speech-language pathologist "strongly agreed" with the implementation of the intervention, proximity fading and task breaks, and supports provided during the group instruction lesson (i.e., visual timer, interval checklist, stipulated signal, visual student behavior rules). In the comments section they both indicated they felt the intervention improved joint attention and group responding of the participants.

However, they "disagreed" with the statement regarding students learning meaningful math skills. Given the assertions of Kasari and Smith (2013) indicating school's preference of adopting curriculum over isolated strategies, this is important information. In fact, the participating teacher is the individual who trials potential curriculum for the county prior to the purchase of new curriculum for classes serving students with ASD. So, she wields great power and influence over the education of students with ASD in this county. During informal discussion at the end of the study, the teacher indicated that CMC-A was “at least something” but, in her opinion, still not optimal for the student’s she serves. When asked if she would recommend this curriculum for her population of students she indicated “no.” The teacher and speech language pathologist were not privy to the students’ pre- and post-test scores on the CMC-A and ASPEN measures because the questionnaires were completed on the final day of intervention prior to the data being calculated although it is difficult to discern whether this would have made a difference in their opinion given the modest mathematics gains. In the comments section of the questionnaire, the teacher and speech language pathologist’s identified specific concerns pertaining to the curriculum including the language demands and pacing of instruction. For example, the speech language pathologist said she was “concerned about the pace of the program and significant amount of language used . . .when there is too much language at a fast pace, students do not learn material.” In addition, the teacher wrote, “the script has too many words” and the was a “rapid pace” which would be “overwhelming” to the students. There have been several research studies indicating the effectiveness of reading and language DI curricula on students’ with ASD literacy and language skills (Flores et al., 2013; Flores & Ganz 2007, 2009; Ganz & Flores, 2009). The curricula used in these studies require an even greater level of language demands than the current study. This may highlight the need to identify ways to ensure that teachers are aware of current research and be motivated to try methods, even with philosophical doubt. Further, research indicates that increased instructional pacing actually improves student performance (Carnine, 1978, Tincani, Ernsbarger, Harrison, & Heward, 2005) including those with ASD (Koegal, Dunlap, & Dyer, 1980; Lamella & Tincani, 2012; Tincani & Crozier, 2008). In fact, Tincani and Crozier (2008) specifically compared brief versus extended wait time during small group DI with two students, one of whom was diagnosed with ASD. Results indicated that brief wait time resulted in more responses per minute, greater percentage of correct responses, and decreased intervals of disruptive behaviors during instruction for both students.

Contributions to the Literature

Previous literature has demonstrated promising results using DI to teach reading , language, and telling time (Flores et al., 2013; Flores & Ganz 2007, 2009; Ganz & Flores, 2009, Thompson et al., 2012). The current study extends the research by examining ways to teach group responding during DI mathematics lessons and measures mathematics performance using both curriculum-based assessments and distal standardized measures. Only one other study has implemented the full DI lesson during reading and language instruction with students with ASD (Flores et al., 2013), but none have investigated the implementing full lessons using DI mathematics curriculum. This study contributes the the literature by investigating full implementation of CMC-A curriculum with students with ASD. Two previous studies have investigated ways to improve group participation during DI instruction (Thompson et al., in preparation; Tincani & Crozier, 2008). Tincani and Crozier (2008) showed positive effects using brief wait time intervals on small group dyadic participation with a student with ASD during brief DI language lessons (Tincani & Crozier, 2008). The student with ASD was able to demonstrate unison responding following a brief training prior to intervention.

The dependent variables were total number of responses, percent correct responses, and percent 5 s intervals of disruptive behavior (i.e., noncompliance, excessive callouts). Number and percent of correct responses increased and intervals of disruptive behavior decreased using brief intertrial intervals (Tincani & Crozier, 2008). Thompson et al. (in preparation) investigated the effects of proximity fading and task breaks on group responding during CMC-A instruction. Using a multiple-baseline across participants, a functional relation was demonstrated between the intervention and percent correct group responses (Thompson et al., in preparation). This current study extended the research by Thompson et al. (in preparation) and Tincani and Crozier (2008) by selecting a younger population with greater intellectual disability, including measures of academic accuracy of responses, and measuring mathematics skill acquisition using both proximal and distal measures. While a functional relation was not replicated by the current study, it adds to the literature by demonstrating that the use of proximity fading and task breaks. While promising, it may not be effective with all populations or may require more systematic and intensive application to increase group response behaviors under different conditions with varied students with ASD.

Limitations

There are several limitations to this study. First, this study was implemented by the experimenter who is a board certified behavior analyst with national board certified teaching credentials and experience teaching DI programs. This limits the generalizability of the study to typical classrooms with teachers who may not have as much experience or behavior analytic expertise. Second, the math implementation was fairly brief. A longer implementation of the CMC curriculum may have revealed more in-depth information on the efficacy of the program and/or problematic components of instruction. Third, the use of videotaping to view and record student performance created challenges to data collection, including obtaining IOA. It was difficult to hear the students well and at times to ascertain who was exhibiting which response.

Recommendations for Future Research

The results of this study have lead to many questions that bear investigating. First, it is clear that due to the heterogeneity of students with ASD further investigation is needed on ways to refine group behavior training for this population. For example, investigating pairing social contingencies with high interest reinforcers to bring group responding behavior under more natural contingences of reinforcement. Second, research investigating systematic increases in task demands and shaping of group response behaviors is warranted. It would be helpful to determine at what point ratio strain occurs and how to avoid this while incrementally increase the intervals between breaks from task demands while also increasing difficulty of tasks. Third, research should investigate what prerequisite skills may be necessary for successful acquisition of group responding behaviors. Suggestions include measuring joint attention skills and investigating whether providing joint attention training prior to group responding instruction increases the effectiveness of the intervention. Fourth, research investigating optimal group size for individuals with ASD is suggested. Researchers should consider the efficiency and effectiveness of various teacher to student ratios. It is possible that for some individuals with ASD, smaller ratios (e.g., one-on-one or two-on-one) may result in more skill acquisition than larger ratios. This must be balanced with efficiency of instruction and use of the teachers’ time. For example, while it may be found that a one-on-one ratio results in a faster rate of acquisition for a student, this may not be the most efficient use of a teacher's time if the teacher can achieve adequate results using group instruction and thereby serve a greater number of students throughout the day. Fifth, implementation by classroom teachers and paraprofessionals should be investigated to determine the feasibility and social validity of implementation by natural agents in the classroom. Researchers should develop investigations exploring the fidelity of implementation of DI by teachers instructing students with ASD. Social validity measure could include traditional questionnaires and Likert scales, but also investigate whether teachers adopt and continue to use DI following the intervention which help lead to conclusions regarding feasibility. Sixth, further research on effects of DI mathematics instruction on mathematics skills of students with ASD is needed. This research should include investigations of optimal dosage of instruction, comparison of group versus individual instruction on mathematics skills acquisition, and component analyses to determine whether changes to the curricula (e.g., thinning introduction of tracks, reduced language demands) may be needed to better support learner characteristics of students with ASD. In addition, investigation of implementation of DI mathematics instruction over a longer period of time such as a semester or year is suggested to determine the effects on mathematics skill acquisition.

Implications for Practice

Given the modest mathematics gains and failure to demonstrate a functional relation for teaching group responding, implications should be approached with caution. DI has been shown to be effective for students with autism (e.g., Flores et al., 2013; Flores & Ganz, 2007, 2009) and may be an effective approach for teaching mathematics skills to students with autism (e.g., Thompson et al., 2012; Thompson et al., in preparation), but effectiveness of DI with small groups of students with ASD is still unclear. Group responding training may be valuable for students with ASD, but development and refinement of specific procedures is still needed.

In summary, the current study has contributed helpful information towards determining effective academic instruction for students with ASD. The question remains as to what type of impact successful group responding may have on supporting students to access instruction and learned skills needed to support school success. Kurth and Mastergeorge (2012) compared students with ASD who received instruction primarily in inclusive settings (>80% of their day) to students with ASD who received instruction primarily in separate settings (>60% of their day). All students included in the study received services in the same setting from Kindergarten to 8th grade. Placement in settings were arbitrary and based almost solely on whether students lived in a district that provided inclusion for all students. Participants were compared for differences in severity of ASD, adaptive behaviors, intelligence quotient (IQ), and academic performance based on scores on the Woodcock Johnson. There were no significant differences between groups in severity of ASD (all were identified as having moderate to severe ASD), adaptive behaviors, and IQ (most had mild to moderate intellectual disability). Notably, there was a significant difference between groups on academic performance of students placed in inclusive settings. Those students scored much higher on the Woodcock Johnson (Woodcock, McGrew, & Mather, 2001) subtests of academic performance. This begs the question, given that academic performance may be significantly increased by just providing students with access to inclusive settings, does group responding matter? It does. First, the results of Kurth and Mastergeorge are preliminary and included only15 students with ASD. Further research is needed to determine if these data can be generalized to the greater population of students with ASD. Second, unfortunately most schools in the United Stated do not offer full inclusive settings for individuals with more severe disabilities, including those with ASD. Factors including behavioral excesses and deficits associated with characteristics of ASD often contribute to placement in more restrictive settings (Machalicek, O'Reily, Beretvas, Sigafoos, & Lancioni, 2007; Scruggs & Mastropieri, 1996). The ability to attend to and participate in group instruction may support access to more inclusive settings. Further, active student participation increases skill acquisition and while some students may be learning observationally via placement in inclusive settings, skill acquisition may be maximized by teaching students to actively participate during instruction. The purpose of tracking not only group responding but also academic accuracy and skill acquisition during this study was to determine if group responding impacted skill acquisition. In the current study, students with ASD increased their math skills following the intervention.

REFERENCES

Akmanoglu, N., & Batu, S. (2004). Teaching pointing to numerals to individuals with autism using simultaneous prompting. *Education and Training in Developmental Disabilities*, *39*, 326–336.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Arick, J. R., Krug, D. A., Fullerton, A., Loos, L., & Falco, R. (2005). School-based programs. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 1003-1028). Hoboken, NJ: John Wiley & Sons, Inc.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis*, *1*, 91–97. doi:10.1901/jaba.1968.1-91

Baron-Cohen, S. (2000). Theory of mind and autism: A fifteen year review. In S. Baren-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from developmental cognitive neuroscience* (2nd ed., pp. 3-20). Oxford, England: Oxford University Press.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind" ? *Cognition*, *21*, 37–46. doi:10.1016/0010-0277(85)90022-8

Bethune, K. S., & Wood, C. L. (2013). Effects of wh-question graphic organizers on reading comprehension skills of students with autism spectrum disorders. *Education and Training in Autism and Developmental Disabilities*, *48*, 236–244.

Bouck, E. C., Satsangi, R., Doughty, T. T., & Courtney, W. T. (2013). Virtual and concrete manipulatives: A comparison of approaches for solving mathematics problems for students with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, Advance online publication. doi:10.1007/s10803-013-1863-2

Boyd, B. A., & Shaw, E. (2010). Autism in the classroom: A group of students changing in population and presentation. *Preventing School Failure*, *54*, 211–219.

Burton, C. E., Anderson, D. H., Prater, M. A., & Dyches, T. T. (2013). Video self-modeling on an IPad to teach functional mathematics skills to adolescents with autism and intellectual disability. *Focus on Autism and Other Developmental Disabilities*, *28*, 67–77. doi:10.1177/1088357613478829

Butler, L. R., & Luiselli, J. K. (2007). Escape-maintained problem behavior in a child with autism: antecedent functional analysis and intervention evaluation of noncontingent escape and instructional fading. *Journal of Positive Behavior Interventions*, *9*, 195–202.

Carnahan, C., & Williamson, P. (2013). Does compare-contrast text structure help students with autism spectrum disorder comprehend science text? *Exceptional Children*, *79*, 347–363.

Carr, E. G., & Durand, V. M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis*, *18*, 111–126. doi:10.1901/jaba.1985.18-111

Center for Disease Control and Prevention. (2012). Prevalence of autism spectrum disorders: Autism and developmental disabilities monitoring network, 14 sites, United States, 2008. *Morbidity and Mortality Weekly Report*, *61*(3), 1-19.

Charlop, M. H., Kurtz, P. F., & Casey, F. G. (1990). Using aberrant behaviors as reinforcers for autistic children. *Journal of Applied Behavior Analysis*, *23*, 163–181. doi:10.1901/jaba.1990.23-163

Chiang, H. M., & Lin, Y. H. (2007). Mathematical ability of students with Asperger syndrome and high-functioning autism:A review of literature. *Autism*, *11*, 547–556. doi:10.1177/1362361307083259

Cihak, D. F., & Foust, J. L. (2008). Comparing number lines and touch points to teach addition facts to students with autism. *Focus on Autism & Other Developmental Disabilities*, *23*, 131–137.

Coleman, M. B., Hurley, K. J., & Cihak, D. F. (2012). Comparing teacher-directed and computer-assisted constant time delay for teaching functional sight words to students with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities*, *47*, 280–292.

Conroy, M. A., Asmus, J. M., Boyd, B. A., Ladwig, C. N., & Sellers, J. A. (2007). Antecedent classroom factors and disruptive behaviors of children with autism spectrum disorders. *Journal of Early Intervention*, *30*, 19–35. doi:10.1177/105381510703000103

Conroy, M. A., Asmus, J. M., Ladwig, C. N., Sellers, J. A., & Valcante, G. (2004). The effects of proximity on the classroom behaviors of students with autism in general education strategies. *Behavioral Disorders*, *29*, 119–129.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Department of Health, Education, and Welfare. (1974). *Records relating to the administration of the Follow Through Program, 1969 - 1974*. Retrieved from http://research.archives.gov/Description/6278127

Durand, V. M. (2005). Past, present, and emerging directions in education. In D. Zager (Ed.), *Autism spectrum disorders*: *Identification, education, and treatment* (pp. 89-109). Mahwah, NJ: Lawrence Erlbaum Associates.

Engelmann, S. (1999, July). *Student-program alignment and teaching to mastery.* Paper presented at the 25th National Direct Instruction Conference. Eugene, OR. Paper retrieved from http://www.zigsite.com/PDFs/StuPro_Align.pdf

Engelmann, S. (2006). *Low performer's manual*. Retrieved from http://www.zigsite.com/PDFs/LowPerfManual.pdf

Engelmann, S. (2007). *Teaching needy kids in our backward system: 42 years of trying*. Eugene, OR: ADI Press.

Engelmann, S., Becker, W., Carnine, D., & Gersten, R. (1988). The direct instruction follow through model: Design and outcomes. *Education &Treatment of Children*, *11*, 303–317.

Engelmann, S., Carnine, D., Kelly, B., & Engelmann, O. (2003). *Connecting Math Concepts: Level B Presentation Book 1*. Columbus, OH: SRA/McGraw-Hill.

Engelmann, S., & Engelmann, O. (2012). *Connecting math concepts: Comprehensive edition level A.* Columbus, OH: McGraw-Hill.

Engelmann, S., Haddox, P., Hanner, S., & Osborne, J. (2002). *Corrective reading thinking basics: Comprehension level A*. Columbus, OH: SRA McGraw-Hill.

Engelmann, S., & Osborne, J. (1999). *Language for learning*. Columbus, OH: SRA/McGraw-Hill.

Engelmann, S., & Osborne, J. (2008). *Language for learning*. Columbus, OH: SRA/McGraw-Hill.

Estes, A., Rivera, V., Bryan, M., Cali, P., & Dawson, G. (2011). Discrepancies between academic achievement and intellectual ability in higher-functioning school-aged children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *41*, 1044–1052.

Ferster, C. B. (1961). Positive reinforcement and behavioral deficits of autistic children. *Child Development*, *32*, 437-456. doi:10.2307/1126210

Flores, M., & Ganz, J. (2007). Effectiveness of Direct Instruction for teaching statement inference, use of facts, and analogies to students with developmental disabilities and reading delays. *Focus on Autism and Other Developmental Disabilities, 22*, 244-251.

Flores, M., & Ganz, J. B. (2009). Effects of Direct Instruction on the reading comprehension of students with autism and developmental disabilities. *Education and Training in Developmental Disabilities, 41*, 39-53.

Flores, M. M., Nelson, C., Hinton, V., Franklin, T. M., Strozier, S. D., Terry, L., & Franklin, S. (2013). Teaching reading comprehension and language skills to students with autism spectrum disorders and developmental disabilities using Direct Instruction. *Education and Training in Autism and Developmental Disabilities*, *48*, 41–48.

Frith, U. (1994). Autism and theory of mind in everyday life. *Social Development*, *3*, 108–124. doi:10.1111/j.1467-9507.1994.tb00031.x

Frith, U. (2008). *Autism: A Very Short Introduction*. Oxford, UK: Oxford University Press.

Frith, U., Happé, F., & Siddons, F. (1994). Autism and theory of mind in everyday life. *Social Development*, *3*, 108-124.

Fuller, P. R. (1949). Operant conditioning of a vegetative human organism. *The American Journal of Psychology*, *62*, 587–590. doi:10.2307/1418565

Ganz, J., & Flores, M. (2009). The effectiveness of Direct Instruction for teaching language to children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 39,* 75-83.

Geiger, K. B., Carr, J. E., & LeBlanc, L. A. (2010). Function-based treatments for escape-maintained problem behavior: A treatment-selection model for practicing behavior analysts. *Behavior Analysis in Practice*, *3*, 22-32.

Gersten, R. (1985). Direct Instruction with special education students: A review of evaluation research. *The Journal of Special Education*, *19*, 41–58.

Gersten, R., Carnine, D., & White, W. A. T. (1984). The pursuit of clarity: Direct Instruction and applied behavior analysis. In W. L. Heward, T. E. Heron, D. S. Hill, & J. Trap-Porter (Eds.), *Focus on behavior analysis in education* (pp. 38-57). Columbus, OH: Charles E. Merrill Publishing Company.

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. S. (2005). Quality indicators for group experimental and quasi-experimental research in special education. *Exceptional Children*, *71*, 149–164.

Geurts, H. M., Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *Journal of Child Psychology and Psychiatry*, *45*, 836–854. doi:10.1111/j.1469-7610.2004.00276.x

Haney, M. R. (2013). *Understanding children with autism spectrum disorders: Educators partnering with families*. Washington, DC: Sage Publications, Inc.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *36*, 5–25. doi:10.1007/s10803-005-0039-0

Harper, J. M., Iwata, B. A., & Camp, E. M. (2013). Assessment and treatment of social avoidance. *Journal of Applied Behavior Analysis*, *46*, 147–160. doi:10.1002/jaba.18

Heflin, L. J., & Alberto, P. A. (2001). Establishing a behavioral context for learning for students with autism. *Focus on Autism and Other Developmental Disabilities*, *16*, 93–101.

Heward, W. L. (2013). *Exceptional children: an introduction to special education*. Upper Saddle River, NJ: Pearson.

Holth, P. (2011). Joint attention in behavior analysis. In E. A. Mayville & J. A. Mulick (Eds.), *Behavioral foundations of effective autism treatment* (pp. 297-320). Cornwall-on-Hudson, NY: Sloan Publishing, LLC.

Horner, R. D., & Baer, D. M. (1978). Multiple-probe technique: A variation of the multiple baseline. *Journal of Applied Behavior Analysis*, *11*, 189–196.

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children*, *71*, 165-179.

Howard, H. A., Ladew, P., & Pollack, E. G. (2009). *The national autism center's national standards project: Findings and conclusions*. Randolph, MA: National Autism Center.

Howlin, P. (2005). Outcomes in autism spectrum disorders. In F. R. Volkmar, R. Paul, A. Klin, D. Cohen (Eds.), *Handbook of autism and pervasive developmental disorders* (pp. 247-287). Hoboken, NJ: John Wiley & Sons, Inc.

Ingvarsson, E. T., Hanley, G. P., & Welter, K. M. (2009). Treatment of escape-maintained behavior with positive reinforcement: The role of reinforcement contingency and density. *Education & Treatment of Children*, *32*, 371–401.

Jameson, J. M., Walker, R., Utley, K., & Maughan, R. (2012). A comparison of embedded total task instruction in teaching behavioral chains to massed one-on-one instruction for students with intellectual disabilities accessing general education settings and core academic content. *Behavior Modification*, *36*, 320–340. doi:10.1177/0145445512440574

Kamps, D. M., Dugan, E. P., Leonard, B. R., & Daoust, P. M. (1994). Enhanced small group instruction using choral responding and student interaction for children with autism and developmental disabilities. *American Journal on Mental Retardation*, *99*, 60–73.

Kasari, C., & Smith, T. (2013). Interventions in schools for children with autism spectrum disorder: Methods and recommendations. *Autism*, *17*, 254-267. doi:10.1177/1362361312470496

Keintz, K. S., Miguel, C. F., Kao, B., & Finn, H. E. (2011). Using conditional discrimination training to produce emergent relations between coins and their values in children with autism. *Journal of Applied Behavior Analysis*, *44*, 909–913. doi:10.1901/jaba.2011.44-909

Kinder, D., Kubina, R., & Marchand-Martella, N. E. (2005). Special education and Direct Instruction: An effective combination. *Journal of Direct Instruction, 5,* 1-36.

Kodak, T., Miltenberger, R. G., & Romaniuk, C. (2003). The effects of differential negative reinforcement of other behavior and noncontingent escape on compliance. *Journal of Applied Behavior Analysis*, *36*, 379–382. doi:10.1901/jaba.2003.36-379

Konrad, M., Helf, S., & Joseph, L. M. (2011). Evidence-based instruction is not enough: Strategies for increasing instructional efficiency. *Intervention in School and Clinic*, *47*, 67–74. doi:10.1177/1053451211414192

Kratochwill, T. R., Hitchcock, J. H., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2013). Single-case intervention research design standards. *Remedial and Special Education*, 34, 26-28. doi:10.1177/0741932512452

Kurth, J., & Mastergeorge, A. M. (2012). Impact of setting and instructional context for adolescents with autism. *Journal of Special Education*, *46*, 36–48.

Leaf, J. B., Tsuji, K. H., Lentell, A. E., Dale, S. E., Kassardjian, A., Taubman, M., … Oppenheim-Leaf, M. L. (2013). A comparison of discrete trial teaching implemented in a one-to-one instructional format and in a group instructional format. *Behavioral Interventions*, *28*, 82–106. doi:10.1002/bin.1357

Ledford, J. R., Gast, D. L., Luscre, D., & Ayres, K. M. (2008). Observational and incidental learning by children with autism during small group instruction. *Journal of Autism and Developmental Disorders*, *38*, 86–103.

Ledford, J. R., Lane, J. D., Elam, K. L., & Wolery, M. (2012). Using response-prompting procedures during small-group direct instruction: Outcomes and procedural variations. *American Journal on Intellectual and Developmental Disabilities*, *117*, 413–434. doi:10.1352/1944-7558-117.5.413

Ledford, J., & Wolery, M. (2013). Peer modeling of academic and social behaviors during small-group direct instruction. *Exceptional Children*, *79*, 439–458.

Levingston, H. B., Neef, N. A., & Cihon, T. M. (2009). The effects of teaching precurrent behaviors on children's solution of multiplication and division word problems. *Journal of Applied Behavior Analysis*, *42*, 361–367.

Lovaas, I., & Smith, T. (1989). A comprehensive behavioral theory of autistic children: Paradigm for research and treatment. *Journal of Behavior Therapy and Experimental Psychiatry*, *20*, 17–29. doi:10.1016/0005-7916(89)90004-9

Loveland, K. A., & Tunali-Kotoski, B. (2005). The school-age child with an autistic disorder. In F. R. Volkmar, R. Paul, A. Klin, D. Cohen (Eds.), *Handbook of autism and pervasive developmental disorders* (pp. 247-287). Hoboken, NJ: John Wiley & Sons, Inc.

Machalicek, W., O'Reilly, M. F., Beretvas, N., Sigafoos, J., & Lancioni, G. E. (2007). A review of interventions to reduce challenging behavior in school settings for students with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *1*, 229-246

May, T., Rinehart, N., Wilding, J., & Cornish, K. (2013). The role of attention in the academic attainment of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *43*, 2147–2158. doi:10.1007/s10803-013-1766-2

Mayton, M. R., Wheeler, J. J., Menendez, A. L., & Zhang, J. (2010). An analysis of evidence-based practices in the education and treatment of learners with autism spectrum disorders. *Education and Training in Autism and Developmental Disabilities*, *45*, 539–551.

Mucchetti, C. A. (2013). Adapted shared reading at school for minimally verbal students with autism. *Autism*, *17*, 358–372. doi:10.1177/1362361312470495

Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. *Journal of Autism and Developmental Disorders*, *20*, 115–128. doi:10.1007/BF02206861

Odom, S. L., Collet-Klingenberg, L., Rogers, S. J., & Hatton, D. D. (2010). Evidence-based practices in interventions for children and youth with autism spectrum disorders. *Preventing School Failure*, *54*, 275–282.

Ozonoff, F., South, M., & Provencal, S. (2011). Executive functions. In E. A. Mayville & J. A. Mulick (Eds.), *Behavioral foundations of effective autism treatment* (pp. 297-320). Cornwall-on-Hudson, NY: Sloan Publishing, LLC.

Pace, G. M., Ivancic, M. T., & Jefferson, G. (1994). Stimulus fading as treatment for obscenity in a brain-injured adult. *Journal of Applied Behavior Analysis*, *27*, 301–305. doi:10.1901/jaba.1994.27-301

Paynter, J., & Peterson, C. C. (2013). Further evidence of benefits of thought-bubble training for theory of mind development in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *7*, 344–348. doi:10.1016/j.rasd.

Pooragha, F., Kafi, S. M., & Sotodeh, S. (2013). Comparing response inhibition and flexibility for two components of executive functioning in children with autism spectrum disorder and normal children. *Iranian Journal of Pediatrics*, *23*, 309–314.

Rajendran, G., & Mitchell, P. (2007). Cognitive theories of autism. *Developmental Review*, *27*, 224–260. doi:10.1016/j.dr.2007.02.001

Reed, G. K., Ringdahl, J. E., Wacker, D. P., Barretto, A., & Andelman, M. S. (2005). The effects of fixed-time and contingent schedules of negative reinforcement on compliance and aberrant behavior. *Research in developmental disabilities*, *26*, 281–295. doi:10.1016/j.ridd.2004.01.004

Reichle, J., Johnson, L., Monn, E., & Harris, M. (2010). Task engagement and escape maintained challenging behavior: Differential effects of general and explicit cues when implementing a signaled delay in the delivery of reinforcement. *Journal of Autism and Developmental Disorders*, *40*, 709–720. doi:10.1007/s10803-010-0946-6

Reichow, B., & Wolery, M. (2011). Comparison of progressive prompt delay with and without instructive feedback. *Journal of Applied Behavior Analysis*, *44*, 327–340. doi:10.1901/jaba.2011.44-327

Reid, D. H., & Favell, J. E. (1984). Group instruction with persons who have severe disabilities: A critical review. *The Journal of The Association for Persons with Severe Handicaps*, *9*, 167–177.

Reinvall, O., Voutilainen, A., Kujala, T., & Korkman, M. (2013). Neurocognitive functioning in adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *43*, 1367–1379. doi:10.1007/s10803-012-1692-8

Rockwell, S. B., Griffin, C. C., & Jones, H. A. (2011). Schema-based strategy instruction in mathematics and the word problem-solving performance of a student with autism. *Focus on Autism and Other Developmental Disabilities*, *26*, 87–95.

Rutter, M. L. (2011). Progress in understanding autism: 2007-2010. *Journal of Autism and Developmental Disorders*, *41*, 395-404.

Scruggs, T. E., & Mastropieri, M. A. (1996). Teacher perceptions of mainstreaming/inclusion, 1958–1995: A research synthesis. *Exceptional Children*, *63*, 59-74.

Semrud-Clikeman, M., Fine, J. G., & Bledsoe, J. (2013) Comparison among children with children with autism spectrum disorder, nonverbal learning disorder and typically developing children on measures of executive functioning. *Journal of Autism and Developmental Disorders*, Advance online publication. doi:10.1007/s10803-013-1871-2

Simpson, R. L., McKee, M., Teeter, D., & Beytien, A. (2007). Evidence-based methods for children and youth with autism spectrum disorders: Stakeholder issues and perspectives. *Exceptionality*, *15*, 203–217.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. Oxford, England: Appleton-Century.

Smith, T. (2012). Evolution of research on interventions for individuals with autism spectrum Disorder: Implications for behavior analysts. *The Behavior Analyst*, *35*, 101-113.

Snell, M. E., & Brown, F. (2011). *Instruction of students with severe disabilities*. Upper Saddle River, N.J.: Pearson.

Stringfield, S. G., Luscre, D., & Gast, D. L. (2011). Effects of a story map on accelerated reader postreading test scores in students with high-functioning autism. *Focus on Autism and Other Developmental Disabilities*, *26*, 218–229. doi:10.1177/108835761142

Taylor, B. A., & Hoch, H. (2008). Teaching children with autism to respond to and initiate bids for joint attention. *Journal of Applied Behavior Analysis*, *41*, 377–391. doi:10.1901/jaba.2008.41-377

Thompson, J. L., Wood, C. L., Test, D. W., & Cease-Cook, J. (2012). Effects of direct instruction on telling time by students with autism. *Journal of Direct Instruction*, *12*, 1–12.

Tincani, M., & Crozier, S. (2008). Comparing brief and extended wait-time during small group instruction for children with challenging behavior. *Journal of Behavioral Education*, *17*, 79–92. doi:10.1007/s10864-008-9063-4

Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development*, *57*, 1454–1463. doi:10.1111/1467-8624.ep7252234

Turner, L. M., Stone, W. L., Pozdol, S. L., & Coonrod, E. E. (2006). Follow-up of children with autism spectrum disorders from age 2 to age 9. *Autism: The International Journal of Research & Practice*, *10*, 243–265. doi:10.1177/1362361306063296

U.S. Department of Education, Office of Special Education and Rehabilitative Services, Office of Special Education Programs. (2012). *31st annual report to congress on the implementation of Individuals with Disabilities Education Act, 2009*. Washington, DC.

U.S. Department of Education, Office of Special Education and Rehabilitative Services, Office of Special Education Programs. (2013). A*nnual report to congress data archive: Part C child count*. Retrieved from http://www.ideadata.org/Archive/30thARC/PartCChildCount.asp

Vollmer, T. R., Marcus, B. A., & Ringdahl, J. E. (1995). Noncontingent escape as treatment for self-injurious behavior maintained by negative reinforcement. *Journal of Applied Behavior Analysis*, *28*, 15–26. doi:10.1901/jaba.1995.28-15

Watkins, C. L. (2008). From DT to DI: Using Direct Instruction to teach students with ASD. *The ABAI Newsletter, 31*(3). 25-29.

Watkins, C. L., & Slocum, T. A. (2004). The components of Direct Instruction. In N. E. Marchand-Martella, T. A. Slocum, & R. C. Martella (Eds.), *Introduction to Direct Instruction* (pp. 28-65). Boston, MA: Pearson.

Watkins, C. L., Slocum, T. A., & Spencer, T. D. (2011). Direct Instruction: Relevance and applications to behavioral autism treatment. In E. A. Mayville & J. A. Mulick (Eds.), *Behavioral foundations of effective autism treatment* (pp. 297-320). Cornwall-on-Hudson, NY: Sloan Publishing, LLC.

Weiss, S. L. (2013). Learning-related behaviors small group reading instruction in the general education classroom. *Intervention in School and Clinic*, *48*, 294–302. doi:10.1177/1053451212472231

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development*, *72*, 655–684. doi:10.1111/1467-8624.00304

Whalen, C., & Schreibman, L. (2003). Joint attention training for children with autism using behavior modification procedures. *Journal of Child Psychology and Psychiatry*, *44*, 456–468. doi:10.1111/1469-7610.00135

Whalon, K., & Hanline, M. F. (2008). Effects of a reciprocal questioning intervention on the question generation and responding of children with autism spectrum disorder. *Education and Training in Developmental Disabilities*, *43*, 367–387.

Whitby, P. J. S. (2013). The effects of Solve It! on the mathematical word problem solving ability of adolescents with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *28*, 78–88. doi:10.1177/1088357612468764

Whitby, P. J. S., & Mancil, G. R. (2009). Academic achievement profiles of children with high functioning autism and asperger syndrome: A review of the literature. *Education and Training in Developmental Disabilities*, *44*, 551–560.

White, W. A. T. (1988). A meta-analysis of the effects of direct instruction in special education. *Education & Treatment of Children*, *11*, 364–74.

Wilczynski, S. M., Fusilier, I., Dubard, M., & Elliott, A. (2005). Experimental analysis of proximity as a social stimulus: Increasing on-task behavior of an adolescent with autism. *Psychology in the Schools*, *42*, 189–196.

Wolery, M., & Ault, M. J. (1992). Choral and individual responding during small group instruction: identification of interactional effects. *Education & Treatment of Children*, *15*, 289–309.

Wong, C. S. (2013). A play and joint attention intervention for teachers of young children with autism: A randomized controlled pilot study. *Autism*, *17*, 340–357. doi:10.1177/1362361312474723

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III tests of cognitive abilities*. Riverside Publishing: Rolling Meadows, IL.

APPENDIX A: PARENT CONSENT FORM

UNCCHARLOTTE

The University of North Carolina at Charlotte
9201 University City Boulevard
Charlotte, NC 28223-0001
Department of Special Education and Child Development

Informed Consent Form for
Teaching Group Participation during Direct Instruction to Students with Autism

What are some general things you should know about research studies?
We are asking permission for your child to take part in a research study. To allow your child to join the study is voluntary. You may refuse to allow your child to join, or you may withdraw your consent of your child's participation in the study, for any reason, without penalty. Research studies are designed to obtain new knowledge. This new information may help people in the future. Your child may not receive any direct benefit from being in the research study. There also may be risks to being in research studies. Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about allowing your child to be in this research study. You will be given a copy of this consent form. You may ask the researchers named below any questions you have about this study at any time.

Researchers:
Julie Thompson, MEd, Graduate Research Assistant, UNC Charlotte, jlthomps@uncc.edu, 704-687-1987
Charles Wood, PhD, Associate Professor, UNC Charlotte, clwood@uncc.edu, 704-687-8395

What is the purpose of this study?
The general purpose of the current study is to develop an in-depth knowledge about effective ways to teach group participation during Direct Instruction lessons to students with autism spectrum disorders. We are asking that your child be in the study because he/she is an elementary student with autism spectrum disorder.

How many people will take part in this study?
There will be 4-8 students with autism spectrum disorders in your child's school that will be asked to participate in this group participation study.

How long will your child's part in this study last?
Your child's participation in this study may last for up to five months. The duration will be 20-30 minutes per day.

What will happen if your child takes part in the study?
Researchers will access your child's educational records to obtain information regarding his/her diagnosis, IQ (if available), and present level of performance. Your child will receive daily group mathematic lessons and brief tutoring sessions on group responding implemented by the primary researcher, Julie Thompson.

Video Recording
By signing this document you are also giving us permission to videotape your child when receiving instruction. The videotapes will be used to record data on the implementation of the intervention. At the end of the intervention teachers and parents (including you) will be shown the videos and asked your opinion of the intervention (e.g., What is your opinion of the teaching method?). In addition, the videotapes may be used in future presentations and/or professional development training outside of this research. Below, you have the option to "opt out" if you do not want videotapes of your child to be used for presentations or professional development in the future.

What are the possible benefits from my child being in this study?
The benefits to society will be the contribution of information regarding effective academic strategies for individuals with autism spectrum disorders. Your child will learn mathematics and group participation skills. You child's teacher may learn potentially effective strategies for meeting the needs of their students with autism spectrum disorders.

What are the possible risks or discomforts involved from being in this study?
We do not anticipate any major risks or discomfort to your child from being in this study.

How will your child's privacy be protected?
Every effort will be taken to protect your child's identity as a participant in this study. Your child will not be identified in any report or publication of this study or its results. Your child's name will not appear on any transcripts; instead, your child will be given a pseudonym. The list, which matches names and pseudonyms, will be kept in a locked file cabinet. Three years after study completion, the list of names and pseudonyms will be destroyed.

Will you receive anything for being in this study?
Your child will receive mathematics and group participation support. You and your child will not receive any monetary payment.

Will it cost you anything to be in this study?
There will be no costs to you or your child for being in the study

What if you have questions about this study?
You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.

What if you have questions about your rights as a research participant?
All research on human volunteers is reviewed by a committee that works to protect your child's rights and welfare. If you have questions or concerns about your child's rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at 704-687-1888 or by email to research@uncc.edu.

- -

Participant's Agreement:
I have read the information provided above. I have asked all the questions I have at this time.

Please check one:

☐ I ***agree*** for my child to participate in this research project.

☐ I ***do not*** agree for my child to participate in this research project.

☐ I agree for my child to participate in this project. However, I do NOT want videotapes of my child's instruction used for presentations or professional development training in the future.

_______________________________________ __________________
Signature of Parent Date

____
Printed Name of Parent

____
Printed Name of Child

APPENDIX B: DATA COLLECTION FORM

Key = Student Initials
A = B = C = D =

Page

Responding During Small Group Instruction

Date:	Data Collector:	Duration:	IOA: Yes No (highlight disagreements, count total agreements) Agreements / total X 100 =

Responding during small group instruction: responding to instructional stimuli within 1 second

1	A	B	C	D	11	A	B	C	D	21	A	B	C	D
2	A	B	C	D	12	A	B	C	D	22	A	B	C	D
3	A	B	C	D	13	A	B	C	D	23	A	B	C	D
4	A	B	C	D	14	A	B	C	D	24	A	B	C	D
5	A	B	C	D	15	A	B	C	D	25	A	B	C	D
6	A	B	C	D	16	A	B	C	D	26	A	B	C	D
7	A	B	C	D	17	A	B	C	D	27	A	B	C	D
8	A	B	C	D	18	A	B	C	D	28	A	B	C	D
9	A	B	C	D	19	A	B	C	D	29	A	B	C	D
10	A	B	C	D	20	A	B	C	D	30	A	B	C	D

Academic Accuracy:
P_A Number of Correct / x 100 = P_B Number of Correct / x 100 =
P_C Number of Correct / x 100 = P_D Number of Correct / x 100 =

+/+ =student responded w/in 1 sec AND academically correct
+/- =student responded w/in 1 sec AND not academically correct
-/ = student did not respond w/in 1 sec

APPENDIX B: DATA COLLECTION FORM CONT.

Page	

	A	B	C	D		A	B	C	D		A	B	C	D
31					47					63				
32					48					64				
33					49					65				
34					50					66				
35					51					67				
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45					61					77				
46					62					78				

APPENDIX C: GROUP INSTRUCTION FIDELITY CHECKLIST

Group Instruction Fidelity Checklist

Date:

Observer:

☐Reviewed start student chart prior to instruction

☐Consistently used “everybody” stipulated signal (< 3 omissions)

☐Consistently provided amplified praise following correct group responding (at least once every 2-3 occurrences)

☐ Marked Time Interval Chart every two minutes

☐Provided 1 minute break after each ten minute interval

☐Provided white boards and markers to students during break

___ % Group Instruction Fidelity

APPENDIX D: TEACHER SOCIAL VALIDITY QUESTIONNAIRE

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I feel that this intervention matched the students' goals for group participation.	**1**	**2**	**3**	**4**
2. The intervention is feasible to implement.	**1**	**2**	**3**	**4**
3. I would use this intervention to teach my students group participation skills in the future.	**1**	**2**	**3**	**4**
4. I believe this intervention would improve the efficiency of my instruction.	**1**	**2**	**3**	**4**
5. The students learned meaningful group participation skills.	**1**	**2**	**3**	**4**
6. The students learned meaningful mathematics skills.	**1**	**2**	**3**	**4**

Additional Comments/Suggestions:

APPENDIX E: PARENT SOCIAL VALIDITY QUESTIONNAIRE

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I feel that this intervention matched the goals for my child.	**1**	**2**	**3**	**4**
2. This was a good intervention for teaching my child group participation.	**1**	**2**	**3**	**4**
3. Group participation is an important skill for my child to learn.	**1**	**2**	**3**	**4**
4. My child learned meaningful group participation skills.	**1**	**2**	**3**	**4**
5. My child learned meaningful mathematics skills.	**1**	**2**	**3**	**4**

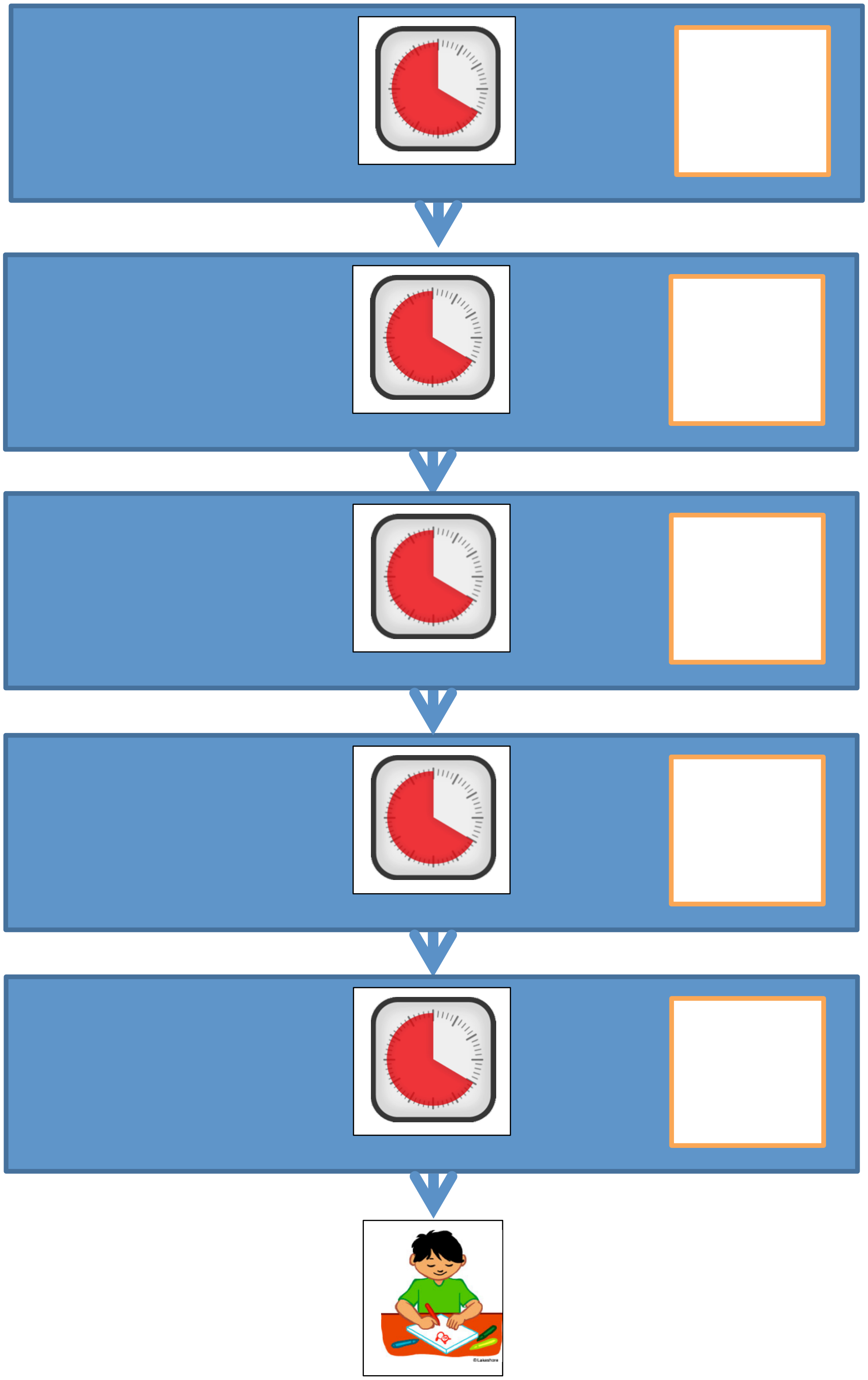
Additional Comments/Suggestions:

APPENDIX F: STAR STUDENT CHART

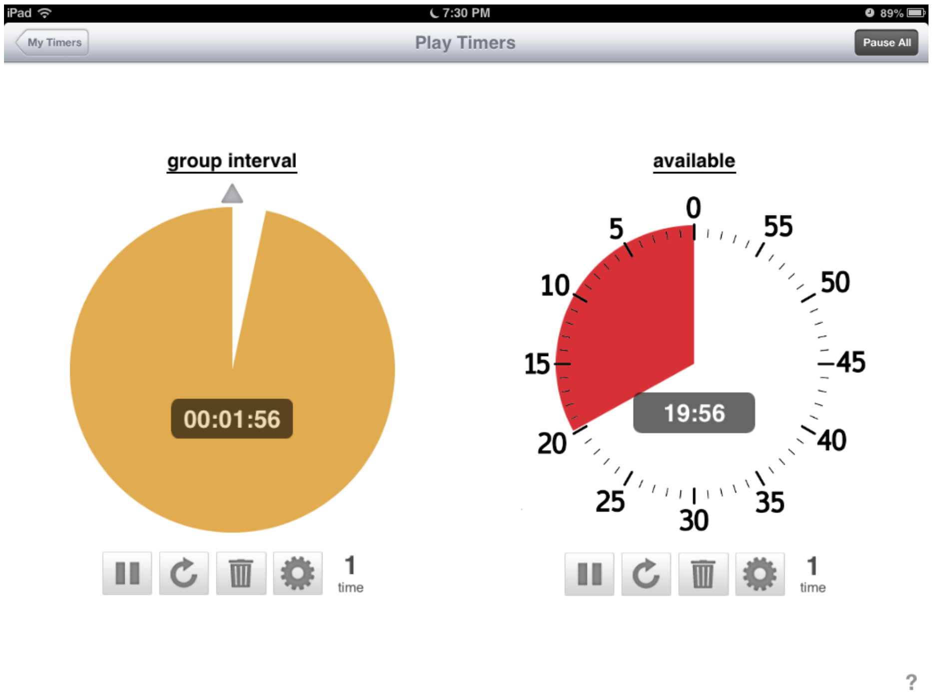
Be a STAR Student

S	 Sit Up	Sit Up
T	 Track	Track with Your Eyes
A	 Answer	Answer on Signal
R	 Respect Others	Respect Others

APPENDIX G: TIME INTERVAL CHART



APPENDIX H: TIMER



APPENDIX I: PRACTICE SESSION FIDELITY

tial intervention step for this session: Observer:

Description	Reinforcement Schedule	Criterion to move to next step	Tallies	Met/Not Met
ɅC-A stimulus and experimenter ɔroximately 9-12 inches from participant. perimenter maintaining direct eye gaze :h participant at all times. Verbal criminative stimulus "everybody" used for :h task.	CRF	3 consecutive correct responses		☐Met ☐Not met
above except: CMC-A stimulus and ɔerimenter approximately **24-36 inches ɔm participant.**	CRF	3 consecutive correct responses		☐Met ☐Not met
above except: CMC-A stimulus and ɔerimenter approximately **48-60 inches ɔm participant.**	CRF faded to IR	10 consecutive correct responses	CRF: ___ IR:	☐Met ☐Not met
above except: **Experimenter varying : gaze between participants and mulus.**	CRF faded to IR	10 consecutive correct responses	CRF: ___ IR:	☐Met ☐Not met
above except: **Verbal discriminative mulus varying between "everybody" d named individual.**	IR	10 consecutive correct responses		☐Met ☐Not met
above except: **Five interval chart from ɅIC-A group instruction introduced with ncontingent break provided at the end five intervals.**	5x30s = 2.5 min Increased to: 5x1min = 5 min Increased to: 5x2min = 10 min	4/5 intervals with 100% group responding then move to next interval	2.5min: ___ 5 min: ___ 10 min:	☐Met ☐Not met

ɔrrect responses return to previous reinforcement schedule or step
less than 100% group responding return to previous interval or step

APPENDIX J: CHOICE BOARD AND VISUAL CUE CARD