Effects of Direct Instruction on the Reading Comprehension of Students with Autism and Developmental Disabilities

Margaret M. Flores
Auburn University

Jennifer B. Ganz
Texas A&M University

Abstract: This study investigated effects of a Direct Instruction reading comprehension program implemented with students with autism spectrum disorders (ASD) and developmental disabilities (DD). There is little research in the area of reading comprehension for students with ASD and no research as to the effectiveness of reading comprehension Direct Instruction (DI). This study extended previous research by investigating the extent to which more complex instruction could be implemented with students with ASD and DD and its effect on their reading comprehension. A multiple probe across behaviors design was used. A functional relation between Direct Instruction and reading comprehension skills and behaviors was demonstrated across all behavioral conditions and across students. Data were also collected using curriculum-based assessments and all student demonstrated improvement. Results and their implications are discussed further.

Though not indicated in diagnostic criteria for pervasive developmental disorders (American Psychiatric Association, 2000), reading comprehension deficits are common in individuals with autism spectrum disorders (ASD). Kanner (1943) initially observed such difficulties in depth of understanding of reading materials in his participants. Individuals with ASD often have delays in both reading decoding and reading comprehension (Nation, Clarke, Wright, & Williams, 2006). However, other individuals with ASD have significant discrepancies between their reading decoding skills, which are relatively high, and their reading comprehension skills, which are relatively low (Newman et al., 2007). That is, reading decoding skills and reading fluency may be at or above levels anticipated by mental age or intelligence, while reading comprehension skills are significantly delayed (O’Conner & Hermelin, 1994; Frith & Snowling, 1983). Ultimately, it is clear that individuals with autism spectrum disorders are a diverse group in terms of reading skills (Nation et al.).

Researchers have investigated a few components of reading comprehension and related skill areas. Nation et al. (2006) found that children with ASD who have deficits in reading comprehension also have deficits in comprehending oral language. Frith (2003) and O’Conner and Klein (2004) noted that integration of contextual information is difficult for individuals with autism. Specifically, Frith and Snowling (1983) found that people with autism have difficulty determining the appropriate homograph given the context of a sentence. Wahlberg and Magliano (2004) investigated reading comprehension in high functioning individuals with autism and observed that they had deficits in connecting previous information with ambiguous texts to assist with comprehension and difficulties making global and abstract connections to what they had read, compared to matched peers. O’Conner and Klein also stated that people with ASD have difficulty monitoring their comprehension as they read. Sandaña and Frith (2007) challenged previous findings, discovering that individuals with ASD read questions as quickly as their matched peers when those questions were related to
previously read texts and more slowly when they were not, as did their peers. They suggest that this indicates reading comprehension difficulties might be caused, not by difficulty making inferences or lack of background knowledge, but instead by difficulties with higher processing skills.

Nation and Norbury (2005) and Snowling and Frith (1986) have asserted that oral language skill deficits have a negative impact on reading comprehension skills in individuals with ASD. Although some individuals with ASD do not speak, even those who do speak and who have normal cognitive functioning often have deficits in language skills (Lord & Paul, 1997). In particular, most individuals with ASD find that abstract and figurative language is difficult to comprehend (American Psychiatric Association, 2000), which directly impacts reading comprehension tasks beyond literal and recall questions. Further, Happé (1994) and Jolliffe and Baron-Cohen (1999) found that high functioning individuals with autism had difficulty understanding stories, particularly when they were required to understand characters’ thought processes. Norbury and Bishop (2002) also discovered story comprehension deficits in high functioning individuals with autism, specifically observing that these individuals had difficulties considering information from multiple sources, made incorrect inferences, had poor short-term memories, and had inefficient working memories. These areas of deficit necessitate research investigating effective and explicit strategies to address oral language skills that are prerequisites for figurative and abstract skills required for reading comprehension.

Interventions in Reading Comprehension for Individuals with ASD

Little research had been conducted regarding methods best suited to teach reading comprehension or prerequisite oral language skills to individuals with ASD. Three studies have demonstrated such methods. O’Conner and Klein (2004) improved reading comprehension in 20 children with ASD via cueing students regarding pronouns referents. Kamps, Barbetta, Leonard, and Delquadri (1994) implemented classwide peer tutoring in an elementary general education classroom that included three children with high-functioning autism, resulting in improvements in reading fluency and comprehension. Flores and Ganz (in press) implemented Direct Instruction (DI) Corrective Reading (Engelmann, Haddox, Hanner, & Osborn, 2002) for reading comprehension with four children with ASD and reading delays, finding that the participants mastered comprehension of statement inference, using facts, and word-based analogies and maintained those skills one month following instruction.

While only one study has reported the effects of DI reading comprehension for children with ASD (Flores & Ganz, 2007), several studies have demonstrated the effectiveness of DI for other children with reading comprehension deficits. Specifically, DI has been used to improve reading comprehension in children in general education classrooms (Maclver & Kemper, 2002; Ryder, Burton, & Silberg, 2006), students with learning disabilities and mental retardation (Carlson & Francis, 2002), English language learners (Carlson & Francis), individuals with epilepsy (Humphries, Neufeld, Johnson, Engels, & McKay, 2005), and students at risk for school failure (Carlson & Francis; Fredrick, Keel, & Neel, 2002; Grossen, 2004). DI reading comprehension approaches have resulted in improvements when implemented with students with reading difficulties across a range of ages, from elementary (Carlson & Francis; Fredrick et al.; Humphries et al.) to middle school (Grossen; Humphries et al.).

Purpose and Research Questions

The purpose of this study was to extend the research regarding the use of DI to improve reading comprehension of students with ASD and developmental disabilities (DD). Flores and Ganz (2007) implemented portions of a DI program and measured student progress with probes that were similar to the program skills and tasks. This study implemented different and more complex portions of the program and in addition to instructional probes, student progress was measured using curriculum-based assessments and standardized assessments. The research study investigated the following: (a) the extent to which more difficult and complex tasks included in the Direct
Instruction program could be implemented with students with ASD and DD and (b) the effectiveness of a Direct Instruction program with regard to reading comprehension skills in students with ASD and DD, specifically investigating their progress in picture analogies, inductions, deductions, and (c) the effect of the DI program on the students’ overall reading comprehension as measured through curriculum-based assessments.

Method

Setting

The setting for the study was a private school for individuals with autism spectrum disorders (ASD) and intellectual disabilities. The school was located on the campus of a small, accredited, private school for elementary and secondary students with high incidence disabilities. The teachers were both state certified educators. One of the teachers was also the Director and was a Board Certified Associate Behavior Analyst (BCABA). The class consisted of ten students, five had ASD, four had mental retardation, and one student had attention deficit hyperactivity disorder.

Participants

Four students participated in the study. All previously attended public schools, were eligible for, and received special education services based on federal guidelines set forth by the Individuals with Disabilities Education Act (IDEA) (1997), the current law at the time of their public school attendance. Two of the students had ASD and two students had developmental disabilities, specifically mental retardation and attention deficit hyperactivity disorder. Hildi was a 12 year old girl in the 5th grade. She had a diagnosis of autistic disorder. As a young child, Hildi was evaluated and diagnosed by a developmental pediatrician; the Pre-linguistic Autism Diagnostic Observation Schedule (DiLavore, Lord, & Rutter, 1995) was included in this evaluation. She qualified for services in the public schools under the category of autism. According to the WJ–III, Hildi’s performance in the area of word and letter identification was low average (standard score = 86), and her performance in the area of passage comprehension was significantly below average (standard score = 67). Sally was an 11 year old girl in the 5th grade. When Sally attended public schools, she qualified for special education services under the other health impairment category because she had a diagnosis of attention deficit hyperactivity disorder. When participating in the study Sally was under the care of a physical and took medication for her condition. Sally was included in the study because attention deficit hyperactivity disorder is considered a developmental disability. According to the WJ–III, Sally’s performance in the area of word and letter identification was low average (standard score = 89) and her performance in the area of passage comprehension was below the average range (standard score = 84). Chad was a 14 year old boy in the 6th grade with a diagnosis of autistic disorder. As a toddler, Chad was diagnosed with autism based on an assessment by his pediatrician; the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Rissi, 1999) was included in this evaluation. He qualified for services in the public schools under the category of autism. According to the WJ–III, Chad’s performance in the area of letter and word identification was within the average range (standard score = 98), and his performance in the area of passage comprehension was significantly below average (standard score = 53). Jane was a 13 year old girl in the 5th grade. When Jane attended public schools, she qualified for special education services under the category of mental retardation and other health impairment because she had a medical diagnosis of attention deficit hyperactivity disorder. According to the WJ–III, Jane’s performance in the area of word and letter identification was significantly below average (standard score = 61) and her performance in the area of passage comprehension was significantly below average (standard score = 28). The students’ background information is summarized in Table 1.

Materials

Reading comprehension instruction was provided using a Direct Instruction program, Cor-
The materials consisted of a scripted teacher presentation book. In order to promote efficient learning, the program is divided into strands of developing skills and each lesson consists of instruction in several strands. The researchers chose three strands for this study: picture analogies, induction, and deductions. These strands appear in successive order within the program. Since the students had previously received instruction, the picture analogy strand was chosen because it followed as the next skill in the sequence of program instruction. The researchers implemented instructional procedures and instructor behaviors as directed in the instructor’s manual. These procedures and behaviors consisted of: (a) following the given script; (b) choral student responses; (c) the use of a clear signal to elicit student responses; (d) correction procedures for incorrect responses or responses that were not in unison; and (e) modeling skills, guiding students by responding with them, and asking students to respond independently.

The researchers created the reading comprehension probes modeled after the tasks and behaviors included in the Direct Instruction program. The probes consisted of eight by eleven inch sheets of paper with instructor scripts for the given skill. For the picture analogy probes, the instructor presented the student with sets of pictures. The first set of pictures represented the first part of an analogy and included one picture, the words, “is to”, and a second picture. The second portion of the picture analogy was a picture, the words, “is to,” and an array of three pictures. For example, one set was a picture of a car, the words, “is to,” and a picture of a tire. The second part of the analogy was a picture of a sailboat and an array that included pictures of water, a person rowing a boat, and a sail. In order to complete this analogy, the participant pointed to the sail which completed the analogy of “car is to tire as sailboat is to sail.”

When presenting the picture analogy probes,
the researchers used a script and said, “Point to the picture that completes the analogy.” For the deduction probes, the researcher presented the student with an array of four pictures of objects and a sentence related to the objects. The student was asked to evaluate three statements regarding pictures and the sentence. For example, the sentence read, “Here is the only thing that Joe did; Joe sat in small boats.” Four pictures of boats followed (large tanker ship, small life raft, small kayak, and large cruise ship). Three statements about Joe and the objects (boats) followed and the student was asked to respond to each statement with “true,” “false,” or “maybe.” The three statements related to Joe and the boats were: Joe sat in object 4, Joe did not sit in object 1, and Joe sat in object 2. The response to, “Joe sat in object 4” was “false” because object 4 was a large cruise ship and the sentence stated that Joe only sat in small boats. Other deduction items involved sentences in which a person performed an action sometimes and the response “maybe” was used in these cases when the statement might be true some of the time. For the induction probes, the instructor read four facts about a particular phenomenon and asked the student to use those facts to generate rules about the phenomenon. For example the four facts were: 1) On Sunday, the clouds came out and the horse ate an apple; 2) On Wednesday, the clouds did not come out and the horse ate a carrot; 3) On Tuesday, the clouds came out and the horse ate an apple; and 4) On Thursday, the clouds did not come out and the horse ate a carrot. After reading those rules, the researcher said, “Tell me the rule about when the clouds came out,” and “Tell me the rule about when the clouds did not come out.” The correct responses were, “When the clouds came out, the horse ate an apple,” and “When the clouds did not come out, the horse ate a carrot.” Correct responses included a complete sentence with both the condition (when the clouds came out) and the behavior (the horse ate an apple). Jane had mastered induction skills prior to instruction based on baseline performances of 100%, so data were collected with another strand, opposites. The researchers read a statement orally and asked Jane to say the statement with the opposite of one of the words within the statement. For example, “Muscles pull to move bones; Now say the statement with the opposite of pull.” A correct response was, “Muscles push to move bones.” Simply stating that the opposite of pull was push was not a correct response.

Procedure

Prior to any instruction, the researchers administered two curriculum-based assessments: (a) the placement test that accompanied the Direct Instruction Program, and (b) a running record that included comprehension questions following a passage that each student read orally. Instruction occurred during regularly scheduled instructional time, for approximately 20 minutes per day. One of the two researchers carried out instruction in a group format. One day per week, both researchers were present in order to verify treatment integrity, and the instructor role switched from week to week. The first author provided instruction three or four days per week and the second author provided instruction one or two days per week.

Through task analysis, the Direct Instruction program divides comprehension skills into smaller chunks of skills and behaviors (Engelmann et al., 2002). The program is divided into strands of developing skills, and each lesson consists of instruction in several strands. Some strands develop over the course of the program, and others begin and end at different points in the program. For the purposes of this study, three strands were initially chosen for instruction and a fourth strand was added because one of the students had already mastered one of the strands. The researchers chose strands based on the students’ current progress within the program and the strands’ successive appearance in the program. The chosen strands were as follows: (a) picture analogies in which students completed an analogy through the use of pictures; (b) deductions in which students evaluated whether an event was true, false, or maybe happened based on a descriptive statement and a series of pictures; (c) inductions in which students generated rules about a particular phenomenon based on a series of facts about the phenomenon; and (d) opposites in which the student listened to a statement and restated the statement using the opposite of
one word within the original statement. Baseline data were collected until each student demonstrated a consistent performance (varying no more than 10%) across three consecutive data points. Daily instruction began with picture analogies and continued until the students reached criterion of three consecutive probes at 100%. After all students reached criterion, picture analogy instruction lessened to 1–2 times per week and deduction instruction began. When all students reached the criterion of three consecutive probes at 100% accuracy, instruction in deductions decreased to 1–2 times per week and daily instruction in inductions began. Jane’s baseline data for inductions were 100% across probes, so data were not collected for Jane although she participated with the group. The group received instruction in inductions and opposites; induction probe data were collected for Hildi, Sally, and Chad and opposites data were collected for Jane. Two sets of maintenance data were collected. The first set (M1) was collected after students met criterion and when instruction decreased to 1–2 times per week. The second set (M2) was collected six weeks after all instruction for all strands ceased.

The researchers administered probes individually prior to daily instruction. There were multiple sets of probes that were given in random order. In the interest of time, probes were not administered to all students on the same day. Two students completed a probe each day prior to instruction resulting to 2–3 probes per week per student.

Treatment Integrity and Inter-observer Agreement

The researchers carried out instruction according to a checklist of teacher behaviors. These behaviors corresponded to the procedures and behaviors prescribed in the Direct Instruction program (Engelmann et al., 2002). Once per week, one of the researchers observed the other providing instruction. Each of the treatment integrity observations was carried out with 100% accuracy. Approximately 75% of the instructional probes were checked for inter-observer agreement. Inter-observer agreement was calculated as the total number of agreements divided by the total number of disagreements and agreements, multiplied by 100. Inter-observer agreement was 97% for these probes. By student, the agreements and disagreements were as follows: (a) 22 agreements and 0 disagreement for Hildi; (b) 19 agreements and 0 disagreements for Sally; (c) 19 agreements and 2 disagreements for Chad; and (d) 19 agreements and 0 disagreements for Jane.

Research Design

A multiple probe across behaviors design was employed. The behavioral conditions were picture analogies, deductions, and inductions (data collected for Hildi, Sally, and Chad), and opposites (data collected for Jane). Baseline data were collected for all four students across all three conditions (for Hildi, Sally, and Chad), and four conditions (for Jane). Direct Instruction for picture analogies began when the data were stable across three consecutive data points. Stability was defined as three consecutive points which did not vary more than 10%. When all students reached the criterion for this condition (three consecutive probes at 100%), Direct Instruction for deductions began. When all of the students reached criterion for this condition (three consecutive probes at 100%), Direct Instruction for inductions (Hildi, Sally, and Chad) and opposites (Jane) began. Instruction continued until the students reached criterion of three consecutive probes at 100% accuracy. Pre-test and post-test data were also collected using curric-
ulum-based assessments in the form of the placement test which accompanied the program and a reading running record which included comprehension questions.

Results

Figures 1–4 present the percentage of correct answers for reading comprehension probes for Hildi, Sally, Chad and Jane. The x-axis represents reading comprehension probes and the y-axis represents the percent correct for each reading comprehension probe.

Hildi

Baseline. During the picture analogies baseline, Hildi’s average performance was 0% with three consecutive probes at 0%. During the deductions baseline, Hildi’s average performance was 0% with three consecutive probes at 0%. During the inductions baseline, her average performance was 0% with three consecutive probes at 0%.

Picture analogies. During the picture analogies condition, Hildi’s mean performance was 100%. She reached criterion in three probes, all at 100%. There was an immediate and
marked improvement in her performance after instruction began in this condition. There is no overlap between baseline and instruction. When instruction decreased to 1–2 times per week during the first maintenance condition (M1), Hildi maintained her performance of 100%. Another maintenance probe was administered six weeks after instruction ended and Hildi maintained her performance of 100%.

**Deductions.** During the deductions condition, Hildi’s mean performance was 83% with probes ranging from 33%–100%. Hildi met criterion in 6 probes; with the exception of one data point, the points show an upward path. There was no overlap between baseline and instruction. When deductions instruction decreased to 1–2 times per week (M1), Hildi maintained her performance at 100%. After six weeks of no instruction (M2), her maintenance performance decreased to 83%.

**Inductions.** During the inductions condition, Hildi’s mean performance was 90% with probes ranging from 75%–100%. She met criterion in 5 probes and the data points show an upward path. There was no overlap between baseline and instruction. When inductions instruction decreased to 1–2 times per week (M1), Hildi maintained her performance at
100%. After six weeks of no instruction (M2), Hildi maintained her performance at 100%.

Curriculum-based assessments. Prior to instruction, Hildi completed the placement test that accompanied the Direct Instruction program. She made 25 errors, placing into level A, lesson 1. After participating in the current study, Hildi made 10 errors, placing into the next level of the program, level B1, lesson 1. Before reading comprehension instruction began, Hildi completed a running record which involved reading a passage at the 2nd grade level and answering 5 comprehension questions (two literal comprehension questions about story events, one question about the main character’s feelings, one question that asked how the reader arrived at the correct answer and one that involved a combination of the readers experience and knowledge of story events). During the pre and post tests, Hildi read the passages fluently and answered questions without access to the passages. Prior to comprehension instruction, she answered 1/5 questions correctly. After instruction, Hildi answered 2/5 questions correctly.

Sally

Baseline. During the picture analogies baseline, Sally’s average performance was 25%
with three consecutive probes at 25%. During the deductions baseline, Sally's average performance was 33% with three consecutive probes at 33%. During the inductions baseline, her average performance was 30% with two probes at 0% followed by three consecutive probes at 50%.

*Picture analogies.* During the picture analogies condition, Sally's mean performance was 100%. She reached criterion in three probes,
all at 100%. There was an immediate and marked improvement in her performance after instruction began in this condition. There was no overlap between baseline and instruction. When instruction decreased to 1–2 times per week during the first maintenance condition (M1), Sally maintained her performance of 100%. Another maintenance probe was administered six weeks after instruction ended and Sally maintained her performance of 100%.

**Deductions.** During the deductions condition, Sally’s mean performance was 97% with probes ranging from 83%–100%. Sally met criterion in 5 probes, showing an upward path. There was no overlap between baseline and instruction. When deductions instruction decreased to 1–2 times per week (M1), Sally maintained her performance at 100%. After six weeks of no instruction (M2), she maintained her performance at 100%.

**Inductions.** During the inductions condition, Sally’s mean performance was 100%. She met criterion in 3 probes, all at 100%. There was a marked and immediate change in performance between baseline and instruction with no overlap of data points. When inductions instruction decreased to 1–2 times per week (M1), Sally maintained her performance at 100%. After six weeks of no instruction (M2), Sally maintained her performance at 100%.

**Curriculum-based assessments.** Prior to instruction, Sally completed the placement test that accompanied the Direct Instruction program. She made 16 errors, placing into level A, lesson 1. After participating in the current study, Sally made 3 errors, placing into the next level of the program, level B1, lesson 1. Before reading comprehension instruction began, Sally completed a running record that involved reading a passage at the 3rd grade level and answering 5 comprehension (two literal comprehension questions about story events, one question about the main character’s feelings, one question that asked how the reader arrived at the correct answer and one that involved a combination of the readers experience and knowledge of story events). During the pre and post tests, Sally read the passages fluently and answered questions without access to the passages. Prior to comprehension instruction, she answered 1/5 questions correctly. After instruction, Sally answered 5/5 questions correctly.

Chad

**Baseline.** During the picture analogies baseline, Chad’s average performance was 50% with three consecutive probes at 50%. During the deductions baseline, Chad’s average performance was 25% with one probe at 0% followed by three consecutive probes at 33%. During the inductions baseline, his average performance was 0% with three consecutive probes at 0%.

**Picture analogies.** During the picture analogies condition, Chad’s mean performance was 100%. He reached criterion in three probes, all at 100%. There was an immediate and marked improvement in his performance after instruction began in this condition. There is no overlap between baseline and instruction. When instruction decreased to 1–2 times per week during the first maintenance condition (M1), Chad maintained his performance of 100%. Another maintenance probe was administered six weeks after instruction ended (M2) and Chad’s maintenance performance decreased to 75%.

**Deductions.** During the deductions condition, Chad’s mean performance was 92% with probes ranging from 83%–100%. Chad met criterion in 6 probes, showing an upward path in the data points. There was no overlap between baseline and instruction. When deductions instruction decreased to 1–2 times per week (M1), Chad maintained his performance at 100%. After six weeks of no instruction (M2), his maintenance performance decreased to 83%.

**Inductions.** During the inductions condition, Chad’s mean performance was 85% with probes ranging from 50%–100%. He met criterion in 5 probes and the data points show an upward path. There was no overlap between baseline and instruction. When inductions instruction decreased to 1–2 times per week (M1), Chad maintained his performance at 100%. After one six weeks of no instruction (M2), Chad’s maintenance performance decreased to 75%.

**Curriculum-based assessments.** Prior to instruction, Chad completed the placement test that accompanied the Direct Instruction program. He made 24 errors, placing into level A, lesson 1. After participating in the current study, Chad made 11 errors, placing into the
next level of the program, level B1, lesson 1. Before reading comprehension instruction began, Chad completed a running record which involved reading a passage at the 3rd grade level and answering 5 comprehension (two literal comprehension questions about story events, one question about the main character’s feelings, one question that asked how the reader arrived at the correct answer and one that involved a combination of the readers experience and knowledge of story events). During the pre and post tests, Chad read the passages fluently and answered questions without access to the passages. Prior to comprehension instruction, he answered 0/5 questions correctly. After instruction, Chad answered 2/5 questions correctly.

**Jane**

**Baseline.** During the picture analogies baseline, Jane’s average performance was 25% with three consecutive probes at 25%. During the deductions baseline, Jane’s average performance was 20% with one increasing data point at 33% followed by three consecutive probes at 17%. During the inductions baseline, her average performance was 100% with three consecutive probes at 100%. During the opposites baseline, Jane’s average performances was 15% with one data point at 0% followed by three consecutive data points at 20%

**Picture analogies.** During the picture analogies condition, Jane’s mean performance was 100%. She reached criterion in three probes, all at 100%. There was an immediate and marked improvement in her performance after instruction began in this condition. There is no overlap between baseline and instruction. When instruction decreased to 1–2 times per week during the first maintenance condition (M1), Jane maintained her performance of 100%. Another maintenance probe was administered six weeks after instruction ended and Jane maintained her performance of 100%.

**Deductions.** During the deductions condition, Jane’s mean performance was 87% with probes ranging from 67%–100%. Jane met criterion in 9 probes with the points showing an upward path. There was no overlap between baseline and instruction. When deductions instruction decreased to 1–2 times per week (M1), Jane maintained her performance at 100%. After six weeks of no instruction (M2), her maintenance performance decreased to 83%.

**Opposites.** During the opposites condition, Jane’s mean performance was 73% with probes ranging from 40%–100%. She met criterion in 6 probes and the data points show an upward path. There was no overlap between baseline and instruction. When opposites instruction decreased to 1–2 times per week (M1), Jane maintained her performance at 100%. After six weeks of no instruction (M2), Jane maintained her performance at 100%.

**Curriculum-based assessments.** Prior to instruction, Jane completed the placement test that accompanied the Direct Instruction program. She made 27 errors, placing into level A, provisional basis. After participating in the current study, Jane made 10 errors, placing into the next level of the program, level B1, lesson 1. Before reading comprehension instruction began, Jane completed a running record that involved reading a passage at the 2nd grade level and answering five comprehension (two literal comprehension questions about story events, one question about the main character’s feelings, one question that asked how the reader arrived at the correct answer and one that involved a combination of the readers experience and knowledge of story events). During the pre and post tests, Jane read the passages fluently and answered questions without access to the passages. Prior to comprehension instruction, she answered 1/5 questions correctly. After instruction, Jane answered 3/5 questions correctly.

**Discussion**

The purpose of this study was to extend the research regarding the use of DI to improve reading comprehension of students with ASD and DD by implementing different and more complex portions of DI and measuring student progress using curriculum-based assessments in addition to instructional probes. A functional relation was demonstrated between Direct Instruction and reading comprehension skills. All students met criterion across the picture analogies, deductions, inductions, and opposites conditions. There were no over-
lapping data points across all students and conditions. Furthermore, there was an immediate and marked change in student performance between baseline and treatment conditions. All of the students maintained their performance after reaching criterion as the frequency of instruction decreased.

Students engaged in the Direct Instruction program without any modifications to the strands of the program presented as were needed in previous research (Flores & Ganz, 2007). Students participated in the form and at the rate prescribed by the program. As Flores and Ganz found, the students followed directions, remained on-task, responded appropriately to instructional demands and tasks without any deviation from the management techniques recommended within the program.

After six weeks without instruction, performance was maintained at a level of 100% across most conditions with the exception of Hildi, whose six week maintenance for deductions decreased to 83% and Chad, whose six week maintenance decreased across all conditions. Chad did not maintain his performance at 100%, but performed at or above 75%, which is well above his baseline performance and might be considered satisfactory in typical classrooms. This extends previous research (Flores & Ganz, 2007) in which the students’ maintenance performance were measured after one month. Another extension of previous research was the addition of curriculum-based assessments as a measure of student progress. All students made marked progress as measured by the program placement test, each placing into the next level of the program. Each student’s comprehension performance as measured through running records improved. Sally made the greatest improvement, from 40% to 100%. Hildi, Chad, and Jane improved and continued to miss the questions that asked the reader (a) how he or she arrived at the correct answer and (b) to combine previous experience with knowledge of story events that involved a combination of the reader’s experience and knowledge of story events. Hildi and Chad also missed the questions that asked the reader about the main character’s feelings. This is consistent with Sandaña and Frith’s (2007) findings that individuals with high functioning autism have difficulty with higher order processing skills which might explain why Hildi and Chad performed better with literal questions than those which involved high order thinking.

Limitations

Direct Instruction (DI) was not compared to any other method or strategy. Therefore the results show that DI was effective for these students rather than demonstrating any advantages of using DI reading comprehension instruction over other forms of instruction. Another limitation of this study is the degree to which the results can be generalized outside of the conditions of the study (Kazdin, 1982). Although the current study extends previous research, a larger group or multiple replications involving students with varied levels of functioning are needed to translate the results to the larger population.

The instructional delivery by the researchers is another limitation (Kazdin, 1982). The first author was trained to implement DI programs as a classroom teacher and certified as a trainer by the Association for Direct Instruction. The first author’s experience with DI may have increased treatment integrity, but may make the results less realistic because the classroom teacher did not implement the program. In order to close the existing gap between research and practice, it is important that classroom teachers successfully implement instructional interventions and maintain their use over time. It is unknown and perhaps unlikely that the classroom teacher will learn the methodology and maintain this type of instruction over time. Presence of the researchers may have skewed the results since students may have been more motivated to participate or behave in different ways with outsiders to the classroom.

Implications and Future Research

There is research regarding the reading characteristics and needs of students with ASD and DD, such as oral language deficits (Nation & Norburry, 2005; Snowling & Frith, 1986), ability to understand characters’ thought processes (Jolliffe & Baron-Cohen, 1999; Happé, 1994), difficulties with higher order thinking skills (Sandaña & Frith, 2007), and making
connections between text and previous learning (Wahlberg & Magliano, 2004). However, less research involving interventions to remediate or compensate for these deficits exists. There is little research in the area of reading comprehension for students with ASD and DD. The Direct Instruction Corrective Reading comprehension series includes explicit instruction in these areas (Engelmann et al., 2002). The program implemented in this study emphasizes oral language comprehension through thinking operations, such as analogies, providing evidence for beliefs or conclusions, classification, deductions, description, inductions, meaning of opposites and meaning of same, statement inferences, and understanding true and false. This program also teaches useful information that increases students’ background knowledge. These are all skills that researchers have identified as deficits for students with ASD and DD. The line of research regarding DI reading comprehension for individuals with ASD and DD is in its initial stages. Flores and Ganz (2007) and the current study have shown that seven strands within one level of the program could be successfully implemented with student with ASD and DD. Further research is needed regarding the efficacy of comprehensive implementations with more students. The effects of long-term use of this program, taking students through all or most of the levels, needs further study. It is also unknown whether long-term use of DI reading comprehension with these populations would be the most efficient and successful form of remediation. Research that involves comparison of the methodologies is needed. Finally, another area of needed research is student progress assessment. This study extended previous research by including curriculum-based assessments, but further research is needed to assess meaningful gains based on students’ individualized educational program (IEP) goals, student performance on statewide assessments, and other measures of progress that are most relevant in schools today.

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