Examining the Effects of Embedding American Sign Language into Literacy Instruction for Students with Autism

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Abstract

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American Sign Language (ASL) has been investigated as a functional communication method for students with intellectual and developmental disabilities and autism spectrum disorder, but has not been investigated as an instructional method for use in literacy tasks in this population. Drawing upon evidence-based practices such as visual supports, neuroscience research investigating brain structures that process speech versus manual language, evidence that ASL promotes functional communication, and Universal Design for Learning (UDL) framework, this intervention addressed the following research question: How does American Sign Language embedded into instruction impact correct academic responding in students with autism spectrum disorder (ASD)? Four middle school students with ASD participated in this alternating treatments study, which embedded various

arrangements of American Sign Language into a shared reading lesson. Implications for practice and research are discussed.

Introduction

Evidence-Based Practices for Autism Spectrum Disorder

Using effective instructional methods with students who have autism spectrum disorder (ASD) is critically important for them to make progress in school (Odom, Brown, Frey, Karasu, Smith-Center, & Strain, 2003). Further, federal law requires that instructional practices are supported by evidence of their effectiveness (National Professional Development Center on Autism Spectrum Disorder [NPDCASD] 2017). Research indicates that certain practices are more effective for students with ASD than others (Odom & Wong, 2015). These 27 evidence-based practices (EBPs) were identified by the National Professional Development Center on Autism Spectrum Disorder (2017). These are important not only for the student to make growth toward academic standards, but to help with functional tasks and life skills, identify appropriate services, and reduce costs for supports (West, McCollow, Umbarger & Cote, 2013). Originally, there were 24 identified evidence-based practices, but in 2014, three more were added suggesting that continuing research investigating instructional methods for students who have ASD may identify additional effective practices (NPDCASD, 2017). Using a variety of evidence-based instructional strategies ensures that students with different strengths, abilities, and needs have access to content and curricula. Allowing students to choose how they engage and respond to content as well as representing content in multiple or alternative ways is a practice called Universal Design for Learning (Coyne, Evans & Karger, 2017).

Universal Design for Learning

Universal Design for Learning (UDL) is a framework for use in all educational settings, not only for environments in which students receive special education services. UDL is a framework that incorporates multiple means of representation, engagement, and expression to provide access to the curriculum for all students (Coyne, Evans & Karger, 2017). Removing barriers and adding supports through a UDL framework has been reviewed as an effective method for supporting students who struggle with literacy tasks (Redford, 2017). An article by Redford (2017) states that UDL promotes reading and academic responding in students with dyslexia or who receive intensive reading support. In this review, Redford (2017) describes UDL supports for literacy including audiobooks, oral reports, and diagrams. By allowing students to receive, engage with, and respond to texts in alternative and preferred manners, these students' reading skills are promoted by UDL rather than hindered by traditional reading and written response tasks (Redford, 2017). Redford (2017) asserts that relying on traditional reading and writing assessments do not adequately evaluate students' comprehension skills if they struggle with the method of responding. This suggests that traditional instruction, including literacy instruction, does not adequately serve and evaluate students with a range of abilities and needs.

A study by Coyne, Evans and Karger (2017) explores the benefit of using UDL with middle school students with intellectual and developmental disabilities (IDD) through the use of computer-based literacy instruction. This intervention was beneficial in that it allowed students to "engage with a UDL environment that provides socially authentic

interactions with peers around age-relevant text, optimizes individual choice and autonomy, and provides appropriate levels of challenge and support," finding that students with IDD can benefit from UDL instructional framework, previously thought to only benefit students in the general education setting (Coyne, Evans & Karger, 2017, p. 11). This suggests implications for future literacy interventions with middle school students whose learning is impacted by disabilities. This study by Coyne, Evans and Karger (2017) utilizes computer-based instructional materials, yet suggests that literacy interventions incorporating UDL through other methods can be beneficial to middle school students with IDD.

Sign Language Use in Language Interventions

Sign language is one way to provide additional means of representation, engagement, and expression for students in accordance with UDL framework. Many instructional methods have been developed to teach sign language systems to students who are Deaf or hard of hearing; these instructional methods have been widely used with Deaf and hard of hearing students, while less research exists of their use with students who have diagnoses of ASD. One of these methods, simultaneous communication, incorporates the simultaneous use of speech and sign (Marmor & Petitto, 1976). Pattison and Robertson (2016) studied simultaneous communication as a method to deliver prompts to hearing students with intellectual disability; their findings suggest that combining speech and sign to deliver prompts increases the student's own mean length of utterance (Pattison & Robertson, 2016).

Two studies have explored the use of ASL with kids with ASD. Bonvillian and Nelson (1976) used American Sign Language (ASL) as an intervention to teach a nonverbal boy with autism functional communication skills. This student was able to acquire functional sign language, showed increases in receptive vocabulary, and improved social behavior once completing the intervention (Bonvillian & Nelson, 1976). The 2009 study by Toth investigated the effect that sign language has on young children with disabilities who are acquiring language. Toth (2009) stated: "When hearing children sign, not only is their existing language being reinforced, but they are able to access another avenue to express a concept they already know, thus creating another connection to that formation in the brain," (p. 87). Additionally, Toth (2009) found that all children in the study made expressive and receptive language gains after being exposed to sign language.

These findings suggest that sign language or a combination of sign language and speech can be an effective practice for use with hearing students with ASD. These studies incorporated sign language interventions with this population of students and found language gains and increased speech output. Very few, if any, statements have been made in the existing literature about these individuals' receptive abilities in comprehending speech versus sign during interventions, and in what ways this may affect academic responding. Toth (2009) stated that more connections in the brain may be created when concepts are reinforced through both auditory and visual representations (speech and sign). In neurodiverse learners who have differing sensory abilities, sign language as an

instructional method has the potential to promote academic engagement and success.

Academic Engagement by Students with ASD

Differing sensory experiences is one of the diagnostic criteria for autism, as outlined in the DSM-5 Diagnostic Criteria by the American Psychiatric Association (Reynolds & Kamphaus, 2013). It is well researched that individuals with autism have increased or decreased sensory sensitivity in response to their environment (Reynolds & Kamphaus, 2013, p. 1). In a brain imaging study evaluating auditory processing, Gervais et al. (2004) stated participants with autism had decreased brain activity in the voice processing areas of the brain and that "abnormal voice processing is a feature of autism" (p. 801). Further, after doing a literature review, Nunes (2008) concluded that individuals with autism often have lower comprehension of verbal language in response to other auditory stimuli. Thus, vocal speech sounds may be harder to attend to and process for individuals with autism (Gervais et al., 2004).

When studying visual attention by tracking eye movements in students with autism, van der Geest, Kemner, Camfferman, Verbaten, and van Engeland (2001) concluded that there was no difference in visual tracking between the individuals with autism and those without autism. Further, this study stated that individuals with autism have unimpaired visual attention and that autism does not imply deficits in visual attention or acuity (van der Geest, Kemner, Cammferman, Verbaten & van Engeland, 2001). Waterhouse and Gillberg (2014) stated that ASD shows varied brain abnormalities across individuals. This idea further supports the necessity of UDL framework in interventions, while the

conclusions by Gervais et al. (2004), Nunes (2008), and van der Geest, Kemner, Camfferman, Verbaten, and van Engeland (2001) lead to the notion that children with autism may be more attuned to instruction in sign language, rather than speech, because of differing levels of auditory engagement in this population and the visuospatial aspect that sign language holds. Sign language may be an effective method in which students can receive visual support, one of the twenty-seven evidence-based practices for students with autism (NPDCASD, Sept. 24, 2017).

Supporting this idea, Toth (2009) states: "[a student] learned to stop his agitation to watch his teacher sign to him," further arguing that some students with low language skills and differing sensory abilities may require a different modality of instruction to perform to their potential (p. 92). Bonvillian and Nelson (1976) also made this assertion, stating a person's verbal processing or speech production skills may be impacted by autism, but their areas of motor processing skills or visual attention may not be impacted, thus the individual is able to master manual forms of language. Temple Grandin, world-renowned animal behavior analyst and individual with autism, regards her visual thinking as an asset (Grandin, 2006). She states:

> I THINK IN PICTURES. Words are like a second language to me. I translate both spoken and written words into full-color movies, complete with sound, which run like a VCR tape in my head. When somebody speaks to me, his words are instantly translated into pictures… I value my ability to think visually, and I would never want to lose it (Grandin, Ch. 1, 2006).

Perhaps sign language is a way to bypass this translation and promote comprehension in individuals with autism who share this thought process.

The findings regarding varied brain structure in individuals with ASD somewhat align with the findings by Proksch and Bavelier (2012), who found that visual attention is heightened in Deaf individuals who use sign language as a first language, and that "anecdotal information suggests that Deaf individuals may display improvements in their remaining senses" to overcome the deficit in their auditory sense (p. 687). Heightened visual attention and lower auditory processing may be a link between individuals who are Deaf and use ASL and individuals with autism. This further supports the notion of using sign language as a visual support in addition to a component of UDL framework in interventions with students who have diagnoses of autism and are more inclined to think visually.

Current Research Focus

Students who are severely impacted by autism learn not only academics, but also adaptive, social, and vocational skills through direct instruction. The foundation of the current study leveraged the evidence by Toth (2009) and Bonvillian and Nelson (1976) teaching students to communicate with ASL, findings regarding visual and auditory engagement in students with autism, positive impacts on language scores when sign language was used in language interventions, existing evidence-based practices, and the framework of Universal Design for Learning. The current study evaluated American Sign Language as an instructional method and its impact on comprehension, measured through correct academic responding in any language modality by students with autism.

The intervention took place during academic work time and embedded signs into literacy instruction; the intervention did *not* explicitly teach ASL as a functional communication skill, but used ASL as an instructional method to deliver academic instruction after preteaching signs to students. Different existing instructional methods combining ASL and spoken English were used in the intervention, which focused on reading comprehension using an adapted young adult novel and structured opportunities to respond to the text by answering multiple choice and sequencing questions. The research question that was asked is as follows: How does American Sign Language embedded into instruction impact correct academic responding in students with autism spectrum disorder?

Method

Participants

The participants for this study were four middle school students with diagnoses of autism spectrum disorder who spent their full school day in a self-contained special education classroom.

Inclusion and Exclusion Criteria. Inclusion criteria for this study included: (a) enrollment as a middle school student (grade six through eight); (b) preexisting diagnosis of autism by a physician; (c) placement in a special education classroom; (d) mastery of at least one level-four (conventional communication) communicative skill in one of the communication function categories (refusal, obtaining, social communication, information sharing) and mastery of level-three communication skills (unconventional communication)

in the remaining communication function categories as measured by the Communication Matrix© (Oregon Health & Science University); (e) IEP goal relating to the intervention in an area such as functional reading, communication, or social/behavioral skills; and (f) sustained engagement for at least 15 minutes when completing a familiar academic task. For the purpose of this study, during pre-intervention observation, sustained engagement in academic tasks was measured as zero instances of the following escape-related behaviors during the task: (a) eloping from work-station, (b) self-injurious behavior, (c) destruction of materials, (d) head on desk or in arms, and (e) loud vocalizations lasting longer than twenty seconds. Participants' functional communication skills and academic engagement were assessed during pre-intervention observation and participants were approved for participation in the study by the researcher. Exclusion criteria for this study included more than two absences from school for the month prior to the intervention implementation or failure to provide parental consent to participate in the study.

Participant Recruitment. The researcher completed student teaching requirements in a middle school self-contained, severe disabilities classroom. For the students in this school meeting inclusion requirements, guardians were given information regarding the study and participation consent forms. Four participants (see Table 1) returned parental consent forms and were approved to participate in the study.

Participant 1: Anna*. Anna was a female student in seventh grade. She had a diagnosis of autism spectrum disorder and was nonverbal with no functional speech. She

* All names have been changed to protect participant confidentiality

used a speech generating device for all functional communication. Her pre-intervention communication score using the Communication Matrix was an average of Level 5 communication skills (concrete symbols) with Level 7 skills (Language) in nine of the 17 communication function categories. In a past evaluation, a school psychologist chose not to assess Anna's intelligence quotient (IQ) due to the profound level that her cognition was impacted by her disability. Anna's family identified as white. Anna's native and only language was English.

Participant 2: Ben. Ben was a male student in eighth grade. Ben had a diagnosis of autism spectrum disorder, and communicated with limited functional speech as well as a speech generating device. Ben had delayed echolalia as well as some spontaneous speech. His pre-intervention communication score using the Communication Matrix was an average of Level 5 communication skills (concrete symbols) with Level 7 skills (language) in 10 of the 17 communication function categories. In a past evaluation, a school psychologist evaluated Ben's IQ to be 40 using the Stanford Binet intelligence scale (Roid, 2003). Ben's family identified as Somali-American and spoke English at home. Ben's native and only language was English.

Participant 3: Christopher. Christopher was a male student in sixth grade. Christopher had a diagnosis of autism spectrum disorder. Christopher had immediate echolalia with little functional speech. He used a speech generating device for the majority of his communication. Christopher's pre-intervention communication score using the Communication Matrix was an average of Level 5 communication skills (concrete symbols)

with Level 7 skills (language) in 10 of the 17 communication function categories. In a past evaluation, a school psychologist chose not to test Christopher's IQ due to the profound level that his cognition was impacted by his disability. Christopher's family identified as Mexican-American and spoke Spanish at home. Christopher's speech generating device had both English and Spanish. Christopher's mother expressed she believed he was predominately an English speaker, however it was apparent that he was emerging bilingual, as he used both languages on his SGD appropriately in respective environments. Christopher received English Language Learner (ELL) services at the time of the intervention.

Participant 4: Dominic. Dominic was a male student who was in sixth grade. Dominic had a diagnosis of autism spectrum disorder and had delayed echolalia as well as functional speech. Dominic used speech for all of his communication. Dominic's pre-intervention communication score using the Communication Matrix was an average of Level 5 communication skills (abstract symbols) with Level 7 skills (language) in 14 of the 17 communication function categories. In a past evaluation, a school psychologist chose not to test Dominic's IQ due to the profound level that his cognition is impacted by his disability. Dominic's family identified as white and Russian. The language used predominately in Dominic's home was Russian. Dominic was fluent in English and did not receive ELL services at the time of the intervention.

Setting

This intervention took place in two special education classrooms at a culturally and

linguistically diverse middle school in the Pacific Northwest. Anna, Ben and Christopher were placed in one special education classroom while Dominic was placed in another special education classroom down the hall. Anna, Ben, and Christopher's classroom ratio was seven students to one lead teacher and three instructional assistants. The researcher of this study was not employed at the school and acted as an additional instructional assistant and student teacher in Anna, Ben, and Christopher's classroom.

The first classroom, Anna, Ben, and Christopher's classroom, was designed for students who needed the most intensive supports. This classroom had seven students: two 6th-graders, two 7th-graders, and three 8th-graders. Five students completed at least one year in this classroom with the same teacher prior to the current school year. Four of the students had diagnoses of autism spectrum disorder, two had diagnoses of Down Syndrome, and one had a diagnosis of Cohen Syndrome.

Every day in this classroom, students watched a 30-minute episode of PBS' *Signing Time!* (Brown & Colman, 2006), which exposed students to functional American Sign Language signs with English narration. Each episode had a different theme, ranging from days of the week to popular food items to family members. Each episode taught approximately of 10 signs and included English songs while the cast sang along. There was no participation requirement or assessment, but students were verbally reinforced for signing along with the video. Students were exposed to functional classroom signs as well. These signs included *sit*, *ready*, *thank you*, *please*, *my turn*, *water*, etc. When signing, teachers paired English words with signs.

The classroom layout included a designated whole-group work area with individual desks and chairs positioned near a white board, another whole-group work area with two large tables, individual designated work stations at three semi-circle tables for one-on-one instruction, and a computer work station. In addition, there were four break areas where students could take breaks independent of others, a leisure area with two couches, and a bathroom. Student supports included individualized visual supports for students depending on specific needs and tasks, visual schedules for each student, noise-cancelling headphones (available upon request), and fidgets, such water timers and Rubik's cubes (available upon request). Additional classroom supports provided were two iPads for class use, a student computer, and a projector.

The second classroom, Dominic's classroom, was designed for students who require less intensive supports. This classroom was co-taught by two special educators and had two instructional assistants to provide support to students. A door separated the classroom into two spaces in which the students transitioned according to the bell schedule. The students in Dominic's class required specially designed instruction in functional academics and social skills and generally worked in small-groups. Some students received services in other classrooms throughout the day. Although some students left this classroom at times to receive instruction elsewhere, Dominic received services in this placement for the entirety of his school day. The classroom typically had 10 to 15 students receiving instruction at a time.

Dominic was not exposed to sign language in his classroom. His class followed the middle-school bell schedule and switched academic and social tasks every hour. The two separated areas of his classroom included 15 single desks, two semi-circle tables, two large tables, two white boards, two projector screens, and 10 computer work stations. Student supports included visuals and fidgets (upon request).

The interventions occurred during one-on-one instruction with the participants, the typical setting in which this population of students receives instruction. For all one-on-one instructional programs, students were seated at a table or desk across from the teacher, positioned away from other students who were working in order to minimize distractions. All participants received the intervention in their typical classroom or work environments; for Dominic, who sometimes received one-on-one instruction outside of his classroom due to his need for more individualized support, the interventions sometimes took place in a work space with which he is familiar in the auditorium.

Materials

Materials necessary for the intervention included: (a) the Communication Matrix© (Oregon Health & Science University) or equivalent functional communication assessment, (b) adapted young adult novel including comprehension questions with consistent Wh-sentence stems (see Figures 1-3), (c) intervention protocol templates specific to each condition and lesson (see Figure 4), (d) writing instrument, (e) semi-circle table, (f) two chairs, (g) electronic timer or watch with second hand, (h) visual support indicating “I’m ready to work” and “I need a break” for students to communicate with the researcher by

pointing (see Figure 5), and (i) social story discussing having new tasks that may be difficult, as participants' inflexibility and discomfort in engaging in new routines had the potential to impact the results of the early intervention sessions (see Figure 6).

Adapted text. The young adult novel *Because of Winn Dixie* by Kate DiCamillo was adapted by the researcher following the guidelines by Hudson, Browder and Wakeman (2013) to meet individual participant needs. The researcher used Boardmaker Studio© to adapt the story with symbol supported text and included repetitions of three specified target words per lesson. The adapted text included: (a) a title page; (b) 23 lessons of text with a one- to two-page summary of the previous section, a multiple choice summary comprehension question, six to eight pages of symbol supported text (see Figure 1), eight multiple choice Wh- questions (see Figure 2) and one Wh- sequencing question to assess comprehension of that section's content (see Figure 3); (c) a page listing the three target words with symbol supported text by Boardmaker Studio© to be pretaught before that section; (d) a "STOP" page at the end of each lesson; and (e) a final "THE END" page after the last lesson. Each lesson was broken into four subsections, each having one to two pages of symbol supported text with six lines per page, and two multiple choice comprehension questions assessing that subsection's content, thus comprehension questions and opportunities to respond were scheduled throughout each lesson.

Each of the 23 lessons of the adapted text had three specified target words to be assessed in that section. Each target word was repeated between five and seven times in its lesson and appeared in the correct responses for two to six questions in its lesson. Since

the correct response to each comprehension question included a target word from that lesson, the participant's comprehension of the target words was being assessed. The final question of each section was a sequencing question with three events that took place in that section. The adapted text had an average Lexile between 300-400, or a second-grade reading level (Lexile Framework for Reading, 2018).

Experimental design. An alternating treatment design was used in accordance with the guidelines provided by Gast and Ledford (2014). There were four intervention conditions, each using a different instructional method to deliver the target words for each session. Three conditions embedded American Sign Language into the literacy lesson, and one used English speech only. These four conditions were repeated rapidly and randomly to control for multi-treatment interference. After each of the four conditions was completed five times by each participant (20 sessions total per participant), the most therapeutic condition for each participant was identified through calculating average scores of correct responding and visual analysis, which was then repeated an additional three times to attempt to establish a stable level of responding and to control for alternation effects. The researcher implemented the intervention by delivering the instruction and collecting response data.

Response Definitions and Measurement

Operational definition of dependent variable. Correct academic responding is defined as a participant answering comprehension questions with the correct answer after listening to the adapted text, question, and multiple-choice answers or event cards read

aloud. Academic responding was accepted through speech, speech generating device, use of signs, physical response (e.g. pointing), or a combination of the four, and depended on the format of the question (e.g. ordering events, multiple choice, etc.). Verbal prompting was delivered when participants did not select an answer or begin to order events within five seconds of the discriminative stimulus. Verbal prompting often included re-reading the question and answer choices or delivering an additional verbal prompt such as "which one?" or "your turn" but never prompted the correct answer until a participant made a selection. The level of verbal prompting used for each question did not affect how a participant's answer was scored since the correct answer was not prompted. The first answer selected by a participant was the recorded response, regardless of whether the participant self-corrected or changed their answer selection. If a participant made an incorrect answer selection, the correct answer was then prompted and the participant was required to select that answer before moving on to the next page.

Data collection on the dependent variable. There were 10 opportunities to respond in each lesson. One response opportunity occurred after a summary and summary question were read about the previous lesson's chapter using the previous lesson's intervention condition, and nine responses occurred throughout the current lesson's chapter. Academic responding was measured in number correct across the nine opportunities to respond to that day's lesson. The response to the summary question was used to measure intervention maintenance. Where response opportunities existed, a space to record correct/incorrect responses was present on the intervention protocol for the

researcher to mark the accuracy of the participants' responses. Included in the intervention protocol was a space to record which communication modality was used to respond for each question.

Each individual participated in intervention sessions two times per week. The data collection period lasted 14 weeks, due to winter and spring breaks, classroom schedules, and participant absences. Each intervention session lasted approximately 10 to 15 minutes.

Operational definition of independent variable. The independent variables were the different instructional methods used to deliver the target words during literacy lessons: (1) speech only, (2) simultaneous communication, (3) sandwiching, and (4) ASL only. The conditions were used as instructional methods to deliver only the three specified target words in each lesson, with all other words in the lesson being delivered through English speech, the way in which these students would typically engage in a shared reading. These four conditions are described below:

1. Speech only: During this condition, the researcher used English speech to implement the entire lesson.
2. Simultaneous communication: This instructional method generally utilizes one language's grammar structure but shows/tells the other language's vocabulary simultaneously (Marmor & Petitto, 1979). During this condition, the researcher used English speech while simultaneously using American Sign Language vocabulary to deliver the target words.

3. Sandwiching: This instructional method repeats a concept in two language modalities by sandwiching them in an A-B-A pattern (Nussbaum, Waddy-Smith & Doyle, 2012). During this condition, the researcher used a sign-speak-sign pattern to deliver the lesson's target words using American Sign Language and English.
4. ASL only: lesson target words were signed while other instructional elements were delivered through English speech. During this condition, the researcher used American Sign Language to deliver the target words.

Procedures

Each session consisted of reading one to two chapters of adapted text, using the appropriate condition to deliver the three target words, and allowing the participant to respond to 10 comprehension questions throughout the reading. The three target words for the session were pretaught to the participant using the condition for that session. Preteaching consisted of multiple repetitions of saying the word using speech, showing the manual sign (if condition allowed), and pointing to the symbol supported text. The steps outlined in the intervention protocol (Figure 4) were implemented according to the condition specified for each session. The schedule of alternating conditions (see Table 2) was created by randomizing sessions using Microsoft® Excel® (Microsoft©, 2017).

For all opportunities to respond across all intervention conditions and sessions, the questions and multiple-choice answers or event cards were read entirely in English, the typical manner in which the participants would receive comprehension assessments. If a participant responded incorrectly, the researcher used verbal error correction which

included reading the correct answer using English in addition to the condition's implementation of ASL to deliver the target word, as well as the controlling prompt, defined as: "stimuli that are added to the target stimulus or after the target stimulus to help the [participant] make the target response", such as "touch (correct answer)," (Mims, 2017). Error correction of event questions consisted of the researcher putting the cards in the correct order and reading each card aloud using English and the condition's implementation of ASL.

A response latency of greater than five seconds prompted the researcher to read the question again with a verbal prompt for the participant to respond (e.g. "your turn" or "which one?"). No physical prompts were used to avoid prompting specific answers (e.g. closest answer to the participant). All participants selected an answer after the discriminative stimulus or one verbal prompt; zero questions were scored as having no response. Each participant's first response in any language modality (sign, speech, physical response, speech generating device) was recorded.

During intervention sessions, if a participant exhibited any of the following escape-related behaviors: (a) physically fleeing work-station, (b) self-injurious behavior, (c) destruction of materials, (d) head on desk or in arms, and (e) loud vocalizations lasting longer than twenty seconds, the participant was given the chance to request a break by touching the "I need a break" portion of the "I'm ready to work/I need a break" visual, in which case a three-minute break was honored before returning to the intervention.

After each session, each participant was verbally praised and reinforced with a primary reinforcer (e.g. skittle or gummy bear) as appropriate for the participants' typical reinforcement schedules. Participants were instructed to join the next activity on their schedule.

Intervention sessions occurred at a similar time of day for each participant, respectively. This controlled for extra-experimental threats and gave participants more consistency in their schedules (Gast & Ledford, 2014). Due to his related services schedule, Dominic's intervention schedule was changed slightly after session 16, in which he began participating in the intervention two hours later in the day than previously.

After the schedule of interventions and data analyses were complete, the most therapeutic condition (MTC) was identified for each participant by calculating raw averages for each condition (number of correct responses out of nine opportunities to respond per lesson). Each participant received the intervention using their respective most therapeutic condition for three addition sessions to attempt to establish stable levels of responding and to control for alternation effects (Gast & Ledford, 2014). The most therapeutic condition was identified by calculating raw averages of participant response scores since no clear separation of data was identifiable in visual analysis for any of the four participants. To support the selection of most therapeutic condition for each participant, anecdotal evidence regarding patterns of responding was used.

Data analysis procedures

Data analysis occurred throughout the intervention, and participants' average

scores of correct responding were calculated after data collection was completed for the first 20 sessions for each participant. After three additional sessions were conducted with each participant using his or her most therapeutic condition, additional data analysis took place. Data analysis included visual analysis of data graphed for the participant pool as a whole as well as individual participant data (Gast & Ledford, 2014).

Social Validity

The purpose of assessing social validity and preference is to inform future instruction for individual students as well as assessing feasibility of future lessons. Social validity was evaluated through a Likert-scale questionnaire distributed to the two lead teachers whose students were participants in this study, and two instructional assistants working in classrooms with these students (see Figure 7). The questionnaire assessed staff willingness and confidence in implementing lessons using alternate language modalities (the different intervention conditions). The scales used to assess both willingness and confidence were numerical scales ranging from one to five, with one being the least willing or confident and five being the most.

A preference assessment to identify participant preference of individual communication method (speech, sign, SGD) and which language modality is preferred for lesson instruction (sign language, speech, or a combination of the two) was conducted with participants (see Figure 8). Participant preference in personal communication method and preference in lesson instruction were assessed as this information is valuable in making curricula, materials, and instruction meaningful and accessible to individuals.

Results

All four participants completed 23 intervention sessions under the four conditions. Across all four conditions, data for all participants had low levels of stability and low levels of non-overlapping data. The stability envelope was declared to be one unit value in either direction from the trend line, as this allows for a range of responses to fall within a 22.2% range (two unit values out of nine values total), or roughly one fourth of total possible responses (Gast & Ledford, 2014). The average percent of non-overlapping data across all four participants was 35%. For the purposes of this study, most therapeutic condition was identified through visual analysis, raw averages, subjective data and percent non-overlapping data for alternating treatment designs in accordance with the procedures outlined by Gast and Ledford (2014). The intervention with the highest average of correct participant responses and highest percent non-overlapping data was concluded as the most therapeutic intervention for each participant (Gast & Ledford, 2014). Although Gast and Ledford (2014) do not identify a minimum acceptable percent non-overlapping data value to identify the most therapeutic condition, the researcher declared this to be 60% non-overlapping data, or three out of five superior data points to all other conditions.

Anna. During the intervention sessions with Anna, she generally tracked all words of the text along with the researcher and mimicked signs during the reading of the story. Anna responded to 98% of responses using a physical response such as an isolated point or putting event cards in order. For 1% of responses, Anna used both a sign of the target word present in the answer as well as a physical response. To respond to the other 1% of

questions, Anna used a sign of the target word present in her selected answer. For all sessions in which Anna used a sign to respond, the condition being used was condition two (simultaneous communication).

Anna was the only participant who was given a break due to external behaviors of escape (as defined above). During an error correction on the last response of lesson 16, Anna crumpled the response cards and attempted to put them in her mouth. On the last page of lesson 19, a "STOP" page indicating the lesson was completed, Anna again crumpled the page and attempted to put it in her mouth. During these two incidents, she was prompted to ask for a break, at which time a three-minute break was honored. After this, she returned to the work station where the error correction was completed without any additional externalizing behaviors indicating escape. This was the only instance of external behaviors of escape displayed by any of the four participants. This behavior (crumpling, tearing, and/or chewing materials) is typical for Anna in her classroom and supports are in place to minimize the occurrence of these behaviors. The consequences for Anna exhibiting these behaviors during her typical classroom activities were followed in response to these behaviors during the intervention (e.g. break away from the task materials, loss of reward after work is completed, prompt to make appropriate fidget request). It is believed that these behaviors are maintained by Anna's sensory needs, and do not display frustration or dissent from activities.

Levels of correct responding. Figure 9 presents the levels of Anna's responding across conditions. Throughout the first 20 sessions, the trends in Anna's accurate response

rate decreased for condition one (speech only), condition two (simultaneous communication), and condition four (ASL only) and increased for condition three (sandwiching). The levels of condition one (speech only) and condition three (sandwiching) were stable within a stability envelope of one unit value away from the trend line for each respective condition. Anna ordered events correctly for five of the 23 sessions she participated in, with no correspondence of correct responding to lesson condition.

Anna's range of correct responding over the first 20 sessions was between one and six correct responses out of nine opportunities to respond, or a range of 11% to 67% correct across all conditions. Making six correct responses out of nine opportunities to respond during lesson 15 (condition four [ASL only]) was an outlier, and did not reflect the average rate of correct responding by Anna during any condition.

Anna's average correct response rate across all conditions during the first 20 sessions was 2.75 correct responses out of nine opportunities to respond, or 31% correct. During condition one (speech only) and condition three (sandwiching), Anna's average correct response levels were measured to be 2.6 and 2.4 respectively, or 29% and 26% correct, lower than her average correct responding for the intervention as a whole.

Both condition two (simultaneous communication) and condition four (ASL only) had an average correct response rate of three out of nine opportunities to respond, or 33.3% correct. Due to the single instance of Anna making six correct responses during lesson 15 (condition four [ASL only]), which was a significantly higher value than recorded

across the rest of her sessions, condition two (simultaneous communication) was chosen to be the most therapeutic condition for Anna since her level of responding during this condition was more stable than in condition four (ASL only). Condition two (simultaneous communication) had 40% non-overlapping data with the other three conditions. Due to this low percentage of non-overlapping data, raw averages in addition to visual analysis and anecdotal data were used to identify the most therapeutic for this participant.

Most therapeutic condition. Anna's most therapeutic condition, condition two (simultaneous communication), was implemented three times after the first 20 sessions to attempt to establish a stable level of responding and to control for alternation effects. The final two sessions reached a stable level of responding within a stability envelope of one unit value, with four correct responses per nine opportunities to respond, which is higher than the average for condition two (simultaneous communication) during the first 20 sessions of the study.

Ben. During the interventions sessions with Ben, he generally did not physically track the text, but if the researcher paused to deliver a sign, Ben said the word aloud either from referencing the text or due to his level of engagement with the signs. Ben generally did not sign along with the researcher or mimic signs. Ben is impacted by severe sensory needs and wears sunglasses in the classroom, which he had access to during the intervention. Because of this, the researcher was unable to see if he was tracking the text with his eyes or listening to the spoken words and watching the signs. Due to needing few prompts for Ben to respond to questions, the researcher felt he had an adequate level of

engagement while wearing his sunglasses, despite not being able to see where his focus was.

When Ben responded, he responded with physical responses (e.g., with a point or ordering event cards without speech) for 55% of responses, with speech for 1% of responses, and with a physical response as well as speech for 44% of responses. On the two sessions in which Ben responded correctly on zero out of nine opportunities to respond (condition one [speech only] and condition four [ASL only], respectively), he responded with speech only for all nine questions. On the session (condition four [ASL only]) in which Ben had the highest accuracy (55.5% correct), he responded to four questions with both physical and verbal responses, and to five questions with physical responses only.

Levels of correct responding. Figure 10 presents the levels of Ben's responding across conditions. Throughout the first 20 sessions, the trend in Ben's accurate response rate increased for condition one (speech only) and condition two (simultaneous communication) and decreased for condition three (sandwiching) and condition four (ASL only). No conditions had stable levels of responding within a stability envelope of one unit value away from the trend line for each respective condition. The range of Ben's correct responding during the first 20 sessions was between zero and five responses correct out of nine opportunities to respond, or a range of 0% to 56%. Ben ordered events correctly for three of the 23 lessons he participated in, with no correspondence of correct responding to lesson condition.

Ben's average correct responding across all conditions for the first 20 sessions was 2.8 correct responses out of nine opportunities to respond, or 31%. During condition four (ASL only), Ben's average response rate was 1.8 correct responses out of nine opportunities to respond, or 20% correct, significantly lower than his average correct responding across all conditions. During condition one (speech only) and condition three (sandwiching), Ben's average correct response rate was measured to be 2.8 and 2.6 respectively, or 31% and 29% correct, relatively close to his overall average across conditions.

Condition two (simultaneous communication) had an average correct response rate of 3.2 out of nine opportunities to respond, or 36% correct. This average is considerably higher than Ben's average correct responding across all conditions. Condition two (simultaneous communication) was chosen to be the most therapeutic condition for Ben. In analyzing Ben's data through visual analysis, condition two (simultaneous communication) has 20% non-overlapping data with the other three conditions. Due to this low percent of non-overlapping data, raw averages in addition to visual analysis were used to identify the most therapeutic condition for this participant.

Most therapeutic condition. Ben's most therapeutic condition, condition two (simultaneous communication), was implemented three times after the first 20 sessions to attempt to establish a stable level of responding and to control for alternation effects. The three additional sessions reached a stable level of responding within a stability envelope of one unit value, with accuracy between three and four correct responses per nine

opportunities to respond, having an average of 3.67 correct responses out of nine opportunities to respond, or 40.7% correct. This level of accuracy is slightly higher than the average for condition two (simultaneous communication) during the first 20 sessions of the study.

Christopher. During the interventions sessions with Christopher, he generally physically tracked the text along with the researcher tracking and reading aloud. Christopher signed along and mimicked the researcher's signs. In several instances, Christopher made spontaneous vocalizations (e.g. saying the target word aloud) while the researcher signed a target word. Christopher is impacted by severe sensory needs and wears noise-cancelling headphones in the classroom, which he had access to during the interventions. Due to needing few prompts for Christopher to respond to the questions, the researcher felt he had an adequate level of engagement while wearing noise-cancelling headphones.

Christopher responded to the questions with physical responses using an isolated point or non-isolated middle finger or thumb for 96% of opportunities, with the sign for a target word present in the answer followed by a physical response (e.g. point) for 2% of opportunities, using speech only for two response opportunities (0.08% of opportunities), and with the sign for a target word present in the answer followed by a physical response (e.g. point) as well as saying the target word present in the answer aloud on one response opportunity (.004% of responses). All of the sessions in which Christopher used a sign in addition to physical point and/or speech to respond were sessions under condition two

(simultaneous communication) or condition three (sandwiching). The session in which Christopher used speech only to respond for multiple responses was also under condition three (sandwiching).

Christopher ordered events correctly for four of the 23 sessions he participated in, with no correspondence of correct responding to lesson condition. For all event-ordering questions, Christopher placed the cards in the same randomized order the researcher read them aloud.

Levels of correct responding. Figure 11 presents the levels of Christopher's responding across conditions. During the first 20 sessions of the intervention with Christopher, the trends across all four conditions decreased. No condition had stable responding within a stability envelope of one unit value. The range of Christopher's correct responding during the first 20 sessions was between one and six responses correct out of nine opportunities to respond, or a range of 11% to 67% correct.

Christopher's average correct responding across all conditions for the first 20 sessions was 3.0 correct responses out of nine opportunities to respond, or 33% correct. During conditions one (speech only) and three (sandwiching), Christopher's average correct response rate was measured to be 2.6 and 2.4 respectively, or 29% and 27% correct, relatively close to, but below, his overall average across conditions.

Christopher's average correct responding during condition four (ASL only) was 3.2 correct responses out of nine opportunities to respond or 35% correct, relatively close to, and above, his overall average correct responding across all conditions.

Condition two (simultaneous communication) had an average correct response rate of 4.0 out of nine opportunities to respond, or 44% correct. This average is considerably higher than Christopher's average correct responding across all conditions and each condition individually. Condition two (simultaneous communication) was chosen to be the most therapeutic condition for Christopher. In analyzing Christopher's data through visual analysis, condition two (simultaneous communication) has 40% non-overlapping data with the other three conditions. Due to a low percentage of non-overlapping data, raw averages in addition to visual analysis were used to identify the most therapeutic condition for this participant.

Most therapeutic condition. Christopher's most therapeutic condition, condition two (simultaneous communication), was implemented three times after the first 20 sessions to attempt to establish a stable level of responding. A stable level within a stability envelope of one unit value was not established during these additional sessions.

Dominic. Dominic did not physically track the text while the researcher read aloud, but generally tracked the text with his eye gaze. During the majority of intervention sessions across all conditions, Dominic vocalized off-topic statements, generally due to delayed-echolalia. When this happened and he talked over the text being read aloud, the researcher redirected Dominic and repeated the section of text.

Dominic did not sign along with the researcher during any conditions, but sometimes vocalized target words when the researcher was delivering target words through ASL. Dominic responded to the questions through speech for 48% of

opportunities. Dominic used an isolated point for 28% of response opportunities. He used speech and an isolated point for respond for 24% of opportunities to respond.

For 11 of the first 20 sessions, Dominic responded to all questions by selecting the last multiple-choice answer presented. It is notable that Dominic engaged in this pattern of selecting the last answer presented for five out of five trials of condition one (speech only), four out of five trials of condition four (ASL only), two out of five trials of condition two (simultaneous communication), and zero out of five trials of condition three (sandwiching). Dominic ordered events correctly for six of the 23 sessions he participated in, with no correspondence of correct responding to lesson condition.

Levels of correct responding. Figure 12 presents the levels of Dominic's responding across conditions. During the first 20 sessions of the intervention with Dominic, the trend for condition one (speech only) was flat. Condition two (simultaneous communication), condition three (sandwiching) and condition four (ASL only) all had negative trends over the course of the intervention. Condition four (ASL only) was the only condition in which a stable level of responding within a stability envelope of one unit value was established. The range of Dominic's correct responding during the first 20 sessions was between one and five responses correct out of nine opportunities to respond, or a range of 11% to 56% correct.

Dominic's average correct responding across all conditions for the first 20 sessions was 3.25 correct responses out of nine opportunities to respond, or 36% correct. During

condition one (speech only), Dominic's average correct response rate was measured to be 2.8, or 31% correct, considerably below his overall average across conditions.

Dominic's average correct responding during condition two (simultaneous communication) and condition four (ASL only) was 3.0 correct responses out of nine opportunities to respond or 33% correct, again below his overall average correct responding across all conditions.

In condition three (sandwiching), Dominic had an average correct response rate of 4.2 out of nine opportunities to respond, or 47% correct. This average is considerably higher than Dominic's average correct responding across all conditions and each condition individually. It is notable that during this condition with high average correct responding, Dominic selected answers from all positions rather than only answers that were presented last, as in other conditions. Condition three (sandwiching) was chosen to be the most therapeutic condition for Dominic. In analyzing Dominic's data through visual analysis, condition three (sandwiching) has 60% non-overlapping data with the other three conditions. Raw averages in addition to visual analysis and anecdotal data were used to identify the most therapeutic condition for this participant to keep consistency in how most therapeutic conditions were selected across all four participants.

Most therapeutic condition. Dominic's most therapeutic condition, condition three (sandwiching), was implemented three times after the first 20 sessions to attempt to establish a stable level of responding, which was not established. In all three of the most therapeutic condition intervention implementations, Dominic selected the last answer

presented for every multiple-choice question, a pattern he previously did not follow during condition three (sandwiching) trials.

Dominic was the only participant who was not exposed to sign language in his classroom. Like the other participants, Dominic's most therapeutic condition used a combined language modality, however he was the only participant whose most therapeutic condition was condition three (sandwiching), while the participants who were exposed to sign language on a daily basis in their classrooms had the most therapeutic condition under condition two (simultaneous communication). Condition three (sandwiching) utilized more repetition (sign-say-sign) of the target words using manual language, which may have acted as a support for Dominic due to his unknown history or exposure to American Sign Language.

Group results. As a group, the average correct responding across all four participants for condition one (speech only) was 2.7 correct responses per nine opportunities to respond or 30% accuracy. This is the lowest average of correct responding across all four conditions. Each participant participated in five trials of condition one (speech only), and scores varied from zero to five responses correct across participants. Participant trends were very similar, with Anna and Christopher having slightly negative trends and Ben and Dominic having slightly positive trends. Anna is the only participant whose level of responding was stable within a one unit value stability envelope for condition one (speech only).

As a group, the average correct responding across all four participants for condition two (simultaneous communication) was 3.3 correct responses per nine opportunities to respond, or 36.6% accuracy, during the first 20 sessions of the intervention for each participant. This is the highest average of correct responding across the four conditions. Each participant participated in at least five trials of condition two (simultaneous communication), with this condition being the most therapeutic condition for Anna, Ben, and Christopher, thus they repeated this condition an additional three times each. The range of responses for condition two (simultaneous communication) is from one to six responses correct per nine opportunities to respond. All participants had a negative trend throughout condition two (simultaneous communication), and no participants had stable levels of responding within a one unit value stability envelope for condition two (simultaneous communication).

As a group, the average correct responding across all four participants for condition three (sandwiching) was 2.9 correct responses per nine opportunities to respond, or 32.2% accuracy, during the first 20 sessions of the intervention for each participant. Each participant participated in at least five trials of condition three (sandwiching), with this condition being the most therapeutic condition for Dominic, thus he repeated this condition an additional three times. The range of responses for condition three (sandwiching) is from one to five responses correct per nine opportunities to respond. Anna had a positive trend line for condition three (sandwiching), and was the only

participant to have a stable level of responding within a one unit value stability envelope. All other participants had negative trends and unstable levels of responding.

As a group, the average correct responding across all four participants for condition four (ASL only) was 2.75 correct responses per nine opportunities to respond, or 30.5% accuracy. Each participant participated in five trials of condition four (ASL only). The range of responses for condition four (ASL only) is from zero to six responses correct per nine opportunities to respond. Anna, Christopher and Dominic have very similar trend lines that are slightly negative. Ben has a more negative trend for condition four (ASL only). Dominic is the only participant to have a stable level of responding within a one unit value response envelope for condition four (ASL only).

The two conditions that utilized single language modality, condition one (speech only) and condition four (ASL only) had the lowest average correct responding across participants and were the only two conditions to have zero correct responses from at least one participant in a single lesson.

The two conditions that utilized blended language modalities, condition two (simultaneous communication) and condition three (sandwiching) had the highest averages of correct responding across all participants, and were both most therapeutic conditions for at least one participant. For Dominic, in the first 20 intervention sessions, his pattern of selecting the last answer presented for every question was most notable in conditions one (speech only) and four (ASL only), the two conditions that utilized a single language modality. Condition two (simultaneous communication) had two sessions of

selecting the last-answers presented for every question, and condition three (sandwiching), his most therapeutic condition, had zero instances of following this pattern during the first 20 sessions of the intervention.

Maintenance of Intervention. The first question of each lesson measured maintenance of the previous lesson's condition. There was one summary (maintenance) question per lesson, yielding five maintenance questions per condition per participant, or 20 maintenance questions per condition total. Between lesson implementations, there was a range of two to five days of latency due to intervention scheduling and weekends. During the first 20 lessons for each participant (lessons before most therapeutic condition implementation), maintenance levels were low in relation to the response averages measuring correct responding, with the exception of condition two (simultaneous communication), which had a relatively high level of maintenance.

Maintenance for condition one (speech only) was recorded as correct in four out of 20 maintenance questions across all four participants, or 20% accuracy. The average accuracy of responses during condition one (speech only) lessons was 30%, thus maintenance for this condition was lower than the session average. Ben and Christopher each answered one condition one (speech only) maintenance question correctly, and Dominic answered two condition one (speech only) maintenance questions correctly, each out of five maintenance opportunities for this condition.

Maintenance for condition two (simultaneous communication) was recorded as correct in 10 out of 20 maintenance questions across all four participants, or 50% accuracy

for condition two (simultaneous communication) maintenance. The average accuracy of responses during condition two (simultaneous communication) was 36.7%, thus maintenance for this condition was higher than the session average. Each participant answered at least one condition two (simultaneous communication) maintenance question correctly; Anna responded correctly for two condition two (simultaneous communication) maintenance questions, Ben responded correctly once, Christopher four times, and Dominic two times, each out of five maintenance opportunities.

Maintenance for condition three (sandwiching) was recorded as correct in five out of 20 maintenance questions across all four participants, or 25% accuracy. The average accuracy of responses during condition three (sandwiching) lessons was 32%, thus maintenance for this condition was lower than the session average. Anna and Dominic each answered one condition three (sandwiching) maintenance question correctly, and Christopher answered three condition three (sandwiching) maintenance questions correctly, each out of five maintenance opportunities for this condition.

Maintenance for condition four (ASL only) was recorded as correct in four out of 20 maintenance questions across all four participants, or 20% accuracy. The average accuracy of responses during condition three (sandwiching) lessons was 30.5%, thus maintenance for this condition was lower than the session average. Anna and Dominic each answered one condition four (ASL only) maintenance question correctly, and Christopher answered two condition four (ASL only) maintenance questions correctly, each out of five maintenance opportunities for this condition.

Interobserver agreement procedures on the dependent variable. Two special educators, who were lead classroom teachers in the two classrooms, were trained to collect data based on accuracy of response and communication modality and recording procedures using the same intervention protocol template the researcher used to collect data. Observer data was analyzed to collect agreement data. Agreement data was collected for 35% of conditions one, two, and four, and 30% of condition three, due to observer absence. The average interobserver agreement for participant responses was 98% agreement, with a range of 95-99% agreement across participants, well above the minimum acceptable rate of agreement of 80% (Gast & Ledford, 2014). The formula used to calculate agreement was number of agreements in participant response, divided by the sum of agreements and disagreements, multiplied by 100 (Gast & Ledford, 2014).

Procedural fidelity. The minimum acceptable procedural fidelity score was set at 80% in accordance with Gast & Ledford (2014). Procedural fidelity was collected by the same two classroom teachers who collected interobserver agreement data. These classroom teachers were trained to identify the different instructional methods used during intervention conditions and were given a procedural fidelity protocol to follow (see Figure 13). The observers were present for roughly one-third (32.6%) of instruction and recorded the instructional method and elements of instruction using the same data sheet the researcher used to collect data. The observers were trained to record any lesson elements that were not implemented or implemented with the incorrect lesson condition for that session. In several instances, the observers had to walk away from the intervention

to manage other students' behaviors, and thus fidelity was marked as unreliable. The procedural fidelity data was used to identify any weaknesses in procedural integrity due to the rapid alternation of procedures due to the nature of an alternating treatment design. The number of lesson steps expressed using correct instructional method, divided by 15 total lesson steps implemented per lesson, and multiplied by 100 yielded the procedural fidelity for that session. The procedures of this study had an average fidelity of 98% fidelity, with a range of 96-100% fidelity across conditions.

Social validity results. For condition one (speech only), condition two (simultaneous communication) and condition three (sandwiching), both teachers marked their confidence as five, contingent upon having reliable resources for learning signs. For condition four (ASL only), the teachers marked their confidence in implementing lessons using this instructional method as an average of 4.5, contingent upon having reliable resources for learning signs. Anna, Ben and Christopher's teacher marked her willingness to implement all conditions, if beneficial to students, as five. Dominic's teacher, who generally provides less support to his students, marked his willingness to implement lessons using any of the conditions as two out of five. His students generally work on literacy lessons by reading silently to themselves or in small groups, rather than one-on-one instruction in the way the intervention was presented to participants.

The two instructional assistants responded with scores of five regarding both their willingness and confidence in implementing literacy lessons using condition one (speech only), condition two (simultaneous communication), and condition three (sandwiching),

contingent upon if the signs were first taught to them. For condition four (ASL only), the average instructional assistant responses for willingness and confidence were four.

Anna and Ben both responded that they prefer stories to be read using a combination of speech and ASL, and indicated their device as their preferred communication method. Christopher responded that he prefers stories to be read using ASL only, and he prefers to sign to communicate. Dominic responded that he prefers stories to be read using ASL only, but he prefers to use his voice to communicate. It is notable that all four participants indicated their preference of literacy lessons taught using either a combined instructional method of ASL and English, or ASL only.

Discussion

There is limited research evaluating the impact of American Sign Language on the academic responding of students with autism spectrum disorder as part of literacy instruction. The results of the current study can add a new point of view to existing literature discussing instructional methods and visual supports being used to teach students with autism.

It is notable that the typical delivery of instruction, condition one (speech only), had the lowest average correct responding across participants. All participants had highest levels of correct responding during combined modality instruction that utilized both ASL and English (condition two and condition three). Maintenance of condition two (simultaneous communication) was also high in relation to other conditions. This suggests that ASL may act in the same way as a visual support by adding meaningful information to

lessons and allowing individuals to create and reinforce connections between concepts as Toth (2009) discusses. Each condition had a combination of arbitrary and iconic signs across the five implementations, and this did not appear to impact correct responding, as meaning was assigned to all signs through preteaching target vocabulary before each lesson. Some signs had been previously taught to participants in their classroom environment, however these signs were distributed between conditions and did not appear to impact correct responding. This suggests if manual signs are to be used in literacy tasks or shared reading lessons, the signs should be pretaught before each lesson, rather than using signs students have been exposed to across environments. Preteaching manual signs before each lesson to assign meaning and then using the signs with speech to reinforce concepts appeared to support the participants in the most beneficial way throughout the intervention. Despite familiarity with sign language before the intervention, all participants showed higher comprehension when pretaught signs were used to support the reading of the text using speech.

Two participants, Anna and Christopher, responded to multiple choice questions by using signs for target words present in the correct answers. In the five response opportunities in which Anna responded using a sign, and the six response opportunities in which Christopher responded using a sign, all answers indicated through sign were correct. In other words, responses made through signs for target words were never made in error. This suggests students were using these signs functionally and had attached meaning to the signs through the preteaching of vocabulary words and reading of the text. This suggests

that using manual language in literacy instruction does in fact create new connections as well as reinforce concepts as Toth (2009) stated. Additionally, this may create a more accessible way of attaching meaning to or expressing a concept for certain students, as Bonvillian and Nelson (1976) assert, since both Anna and Christopher have limited or no verbal output, but were able to comprehend concepts and respond accurately through the use of manual signs.

Afacan, Wilkerson, and Ruppar (2017) discuss the benefits of multicomponent literacy instruction for students with intellectual disability. Aspects of beneficial multicomponent literacy instruction, such as tracking text and reading aloud, were utilized in this study with the participants (Afacan, Wilkerson & Ruppar, 2017). American Sign Language as an additional support layered onto multicomponent lessons was seen to have slight benefits for all four participants in this study. With additional research in this area, perhaps American Sign Language can be viewed as a beneficial aspect of multicomponent literacy instruction in accordance with the research compiled by Afacan, Wilkerson, and Ruppar (2017).

Overall, the scores of correct responding during all conditions were low, with low levels of stability and percent non-overlapping data. One reason for this may be the level of text (Lexile 30-400) being too high for the participants, thus comprehension overall was low. Another reason could be opportunities to respond not occurring soon enough after the content was addressed in the text. It's possible that after two pages of text, the participants were not able to recall the details present in the questions. Another possible barrier

present in the interventions was the adapted text that was selected. Although adapted to fit the needs of the participants, the text was a first-person novel. The participants' histories reading fiction is unknown, but in their current classroom placements, fiction is not read regularly. The text being distinct from other classroom activities was one reason it was selected for this intervention. However, as Sally and Hill (2005) state, "individuals with autistic spectrum disorders (ASD) fail to understand not only that others have minds, but also that other minds have different thoughts, and that behaviour is determined by mental states. Thus, individuals with autism are considered to lack a 'theory-of-mind,'" (p 74). Although there is no current research done to assess individuals with autism and their comprehension of first-person, fiction texts, lacking theory-of-mind most likely impacts the way an individual with autism spectrum disorder processes and understands characters' points of view, thoughts, and actions. Thus, selecting a text that is written in the first-person point of view and narrated by a single character may act as a barrier to the participants included in the study if they cannot place themselves in the character's point of view. The text being fiction and not connected to the participants' experiences may also be a barrier to their comprehension. Perhaps a more concrete text written in third-person or a non-fiction text would have increased comprehension scores, potentially increasing comprehension during most therapeutic conditions and yielding higher rates of non-overlapping data. Future research should examine the impact of text structure on student responding.

Implications for Practice

All participants in this study showed higher levels of correct responding when ASL was used to support the reading of an adapted text. Much like visual supports being used to support students with autism, manual signs add additional information, create language pathways, and reinforce concepts when speech alone is a less accessible way of implementing instruction for individual students (Odom & Wong, 2015; Toth, 2009). These results can extend to classroom practice by using ASL to implement the UDL framework and thus allowing ASL to be an alternate mode of expression, representation, and engagement for students (Coyne, Evans, & Karger, 2017).

Since ASL is a true language, it has vocabulary that extends across content areas and environments (Harrington, 2015). This means that speech supplemented with ASL may be used as an instructional method across content areas to potentially increase expression, engagement, and correct responding in students with autism. These implications can impact all areas in which students with autism may receive instruction including academic, adaptive, social, behavioral, and communication skills.

Possible Limitations.

The researcher identified multiple limitations for this study. The first limitation is that simultaneous communication and sandwiching have not been recognized as true languages, and may not act as functional means of communication outside of the intervention setting. The second limitation is that the researcher was a student teacher in the school in which this research was conducted, and had relationships with all four

participants prior to the study being conducted. Lastly, the third limitation is that the sample size in this study is relatively small and may not reflect data if the study were to be repeated using a larger sample size.

Conclusion

American Sign Language is believed to reinforce existing mental concepts, create new connections, increase speech output, and be processed more efficiently than speech in individuals with autism spectrum disorder (Gervais et al., 2004; Marmor and Petitto, 1979; Toth, 2009). More research is needed to understand how American Sign Language or other manual language systems support individuals with autism and their comprehension of literacy tasks. Identifying a link between the evidence-based practice of visual supports and American Sign Language has the potential to serve students in more comprehensive ways across content areas, including academic, communicative, social, and behavioral environments (NPDCASD, 2017). Research investigating theory-of-mind and comprehension of first-person and fiction texts by students with autism spectrum disorder would also be beneficial in understanding supports and interventions for students experiencing barriers in literacy instruction.

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Appendix

Table 1

Individuals participating in study

Name*	Grade	Communication Level	IQ	Native Language(s)
Anna	7	Concrete symbols	Not assessed	English
Ben	8	Concrete symbols	40	English
Christopher	6	Concrete symbols	Not assessed	Spanish, English
Dominic	6	Concrete symbols	Not assessed	Russian, English

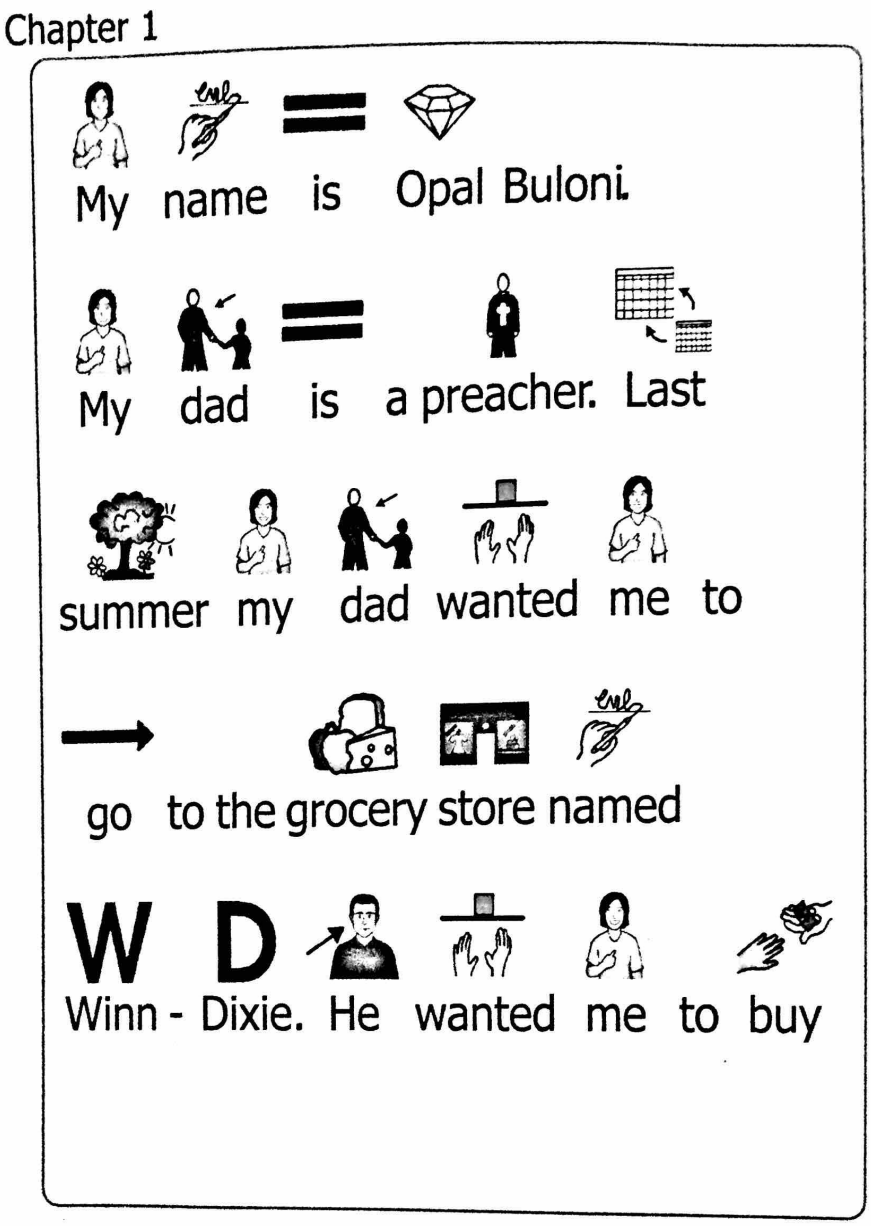
*All names have been changed

Table 2

Schedule of alternating conditions.

Session number	Intervention condition
1	1
2	2
3	4
4	2
5	1
6	2
7	3
8	1
9	4
10	3
11	3
12	4
13	2
14	1
15	4
16	2
17	3
18	4
19	3
20	1

Figure 1 Excerpt of adapted text



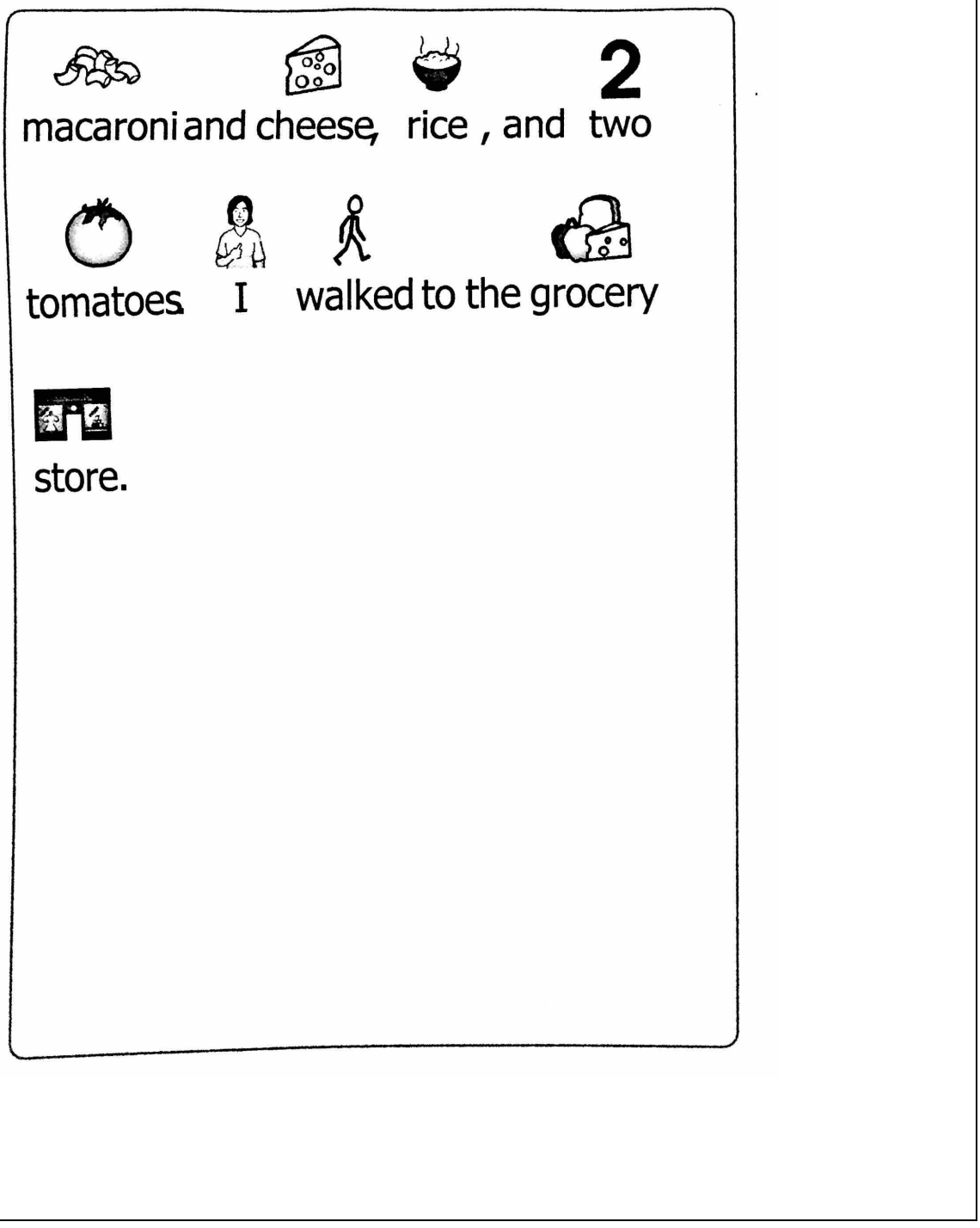

macaroni and cheese, rice , and two
tomatoes. I walked to the grocery
store.

Figure 2 Example of multiple choice question with Wh- sentence stem

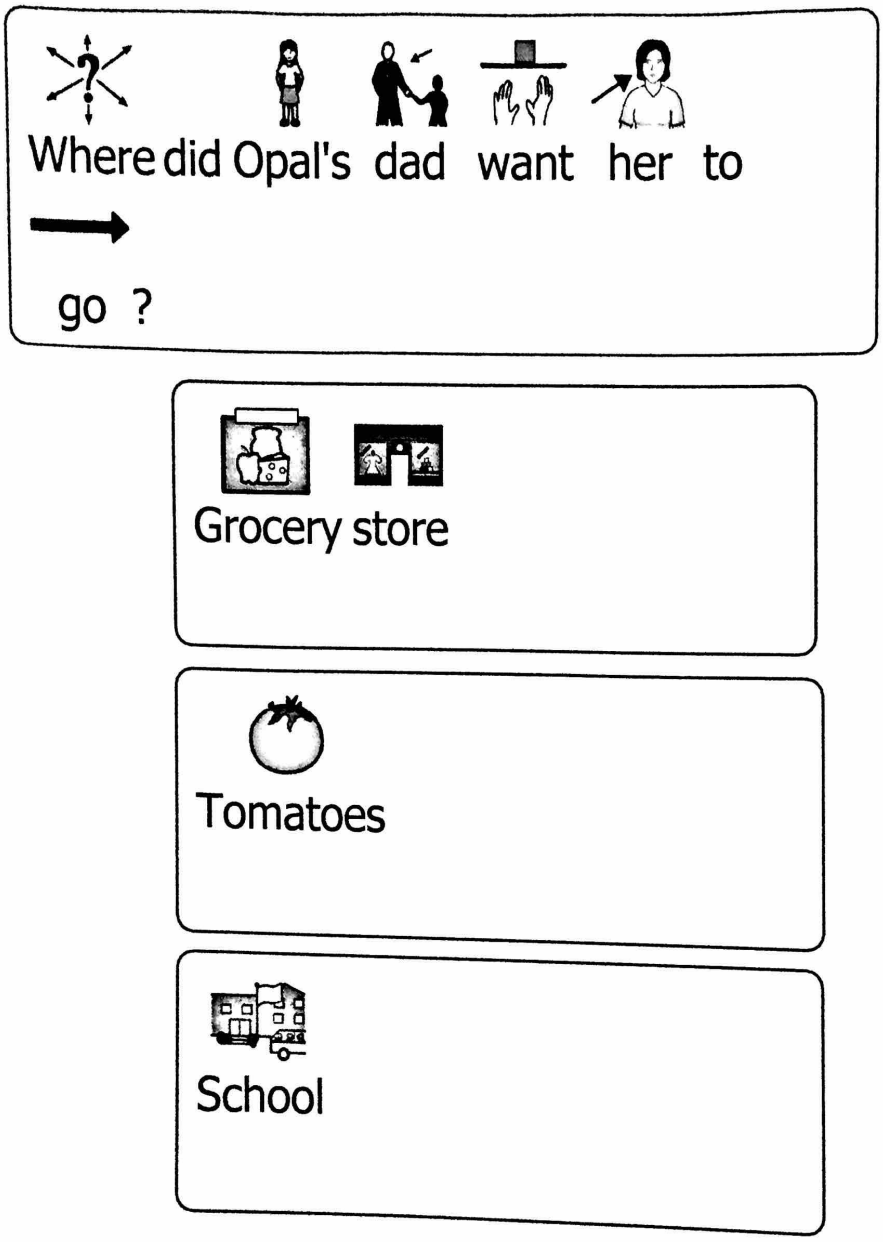


Figure 3 Example of sequencing question with Wh- sentence stem

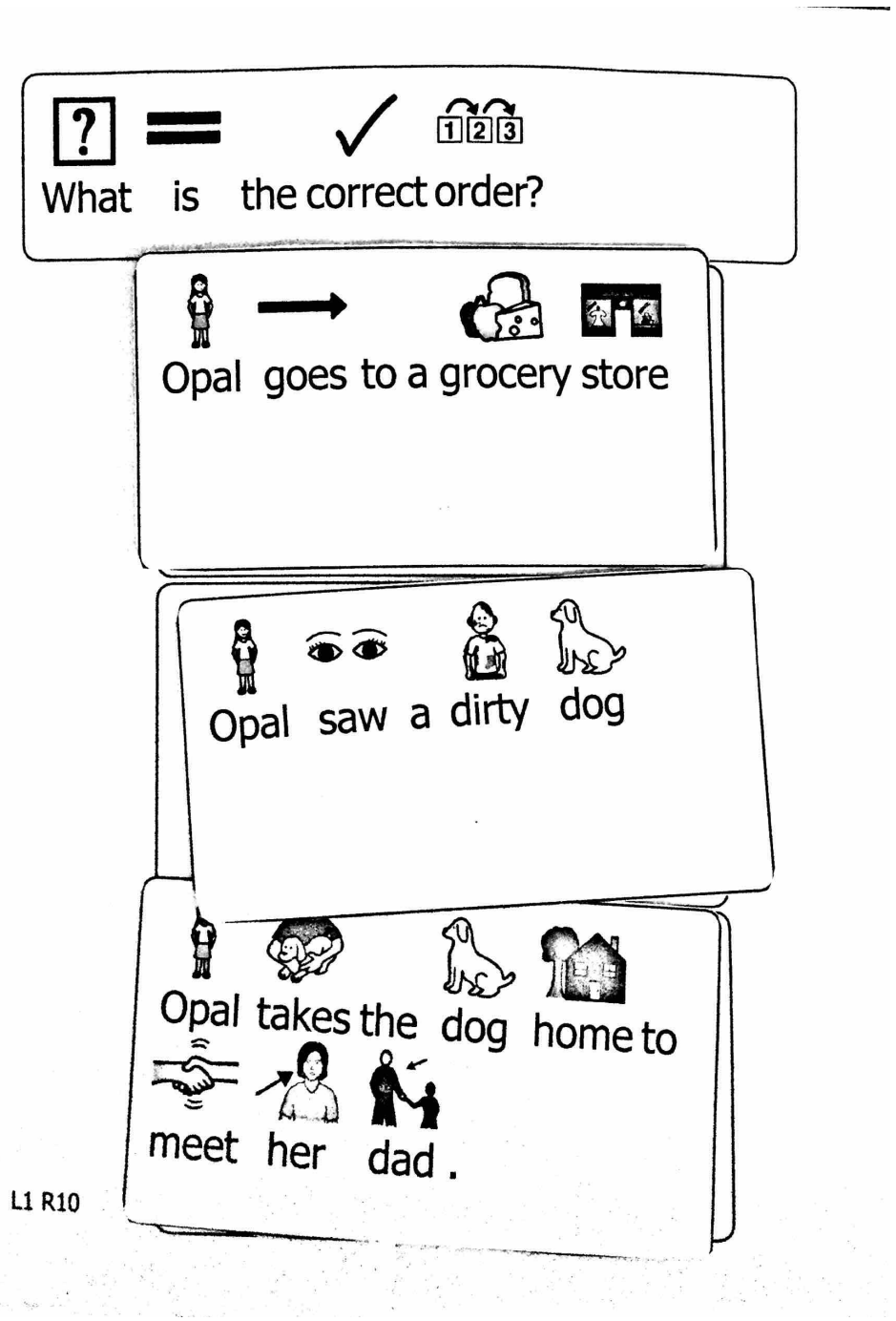


Figure 4 Intervention Protocol Example, Lesson 1

Participant ID: ***sample participant*** **Intervention Condition:** ***1***	**Date of Instruction:** ***mm/dd/yyyy***
Target Words: 1. *grocery store* 2. *dog* 3. *dad*	
Intervention Implementation • Read social story if session 1-10 • Place copy of adapted novel with symbol supported text in front of participant and read title. • Encourage participant to look at text/instructor during lesson. • When reading aloud, track words with finger or pointer. • Record participant response data in right column as lesson progresses.	
1. Read summary section to participant using summary condition *_1__* 2. Read summary question and MC answers to participant. *Key: a girl and her new dog*	Response: + -- Response Modality: sp sgd sign phys
Define Target Words - embed signs if required by intervention condition "This section is about…" 1. *grocery store* 2. *dog* 3. *dad*	
3. Read first subsection of lesson to participant using intervention condition *_1_* 4. Read question and MC answers to participant *key: grocery store*	Response: + -- Response Modality: sp sgd sign phys

5. Read question and MC answers to participant *key: a grocery store* 6. Read second subsection of lesson to participant using lesson condition *1_* 7. Read question and MC answers to participant *key: a dog* 8. Read question and MC answers to participant *key: inside the grocery store* 9. Read third subsection of lesson to participant using lesson condition *__1_* 10. Read question and MC answers to participant *key: Opal's dad* 11. Read question and MC answers to participant *key: Opal and her dad* 12. Read fourth subsection of lesson to participant using lesson condition *_1__* 13. Read question and MC answers to participant *key: Opal's dad*	Response: + -- Response Modality: sp sgd sign phys Response: + -- Response Modality: sp sgd sign phys Response: + -- Response Modality: sp sgd sign phys Response: + -- Response Modality: sp sgd sign phys Response: + -- Response Modality: sp sgd sign phys Response: + -- Response Modality: sp sgd sign phys	

14. Read question and MC answers to participant *key: the dog* 15. Read sequencing question and event cards to participant *key: 1. Opal went to the grocery store* *2. Opal saw a dirty dog* *3. Opal's dad was not happy* Show participant STOP page and conclude lesson.	Response: + -- Response Modality: sp sgd sign phys	
Notes:	**Overall % correct:** **Response Modality Breakdown:** **sp sgd sign phys** **____% ____% ____% ____%**	

Figure 5 "I'm ready to work" and "I need a break" visual

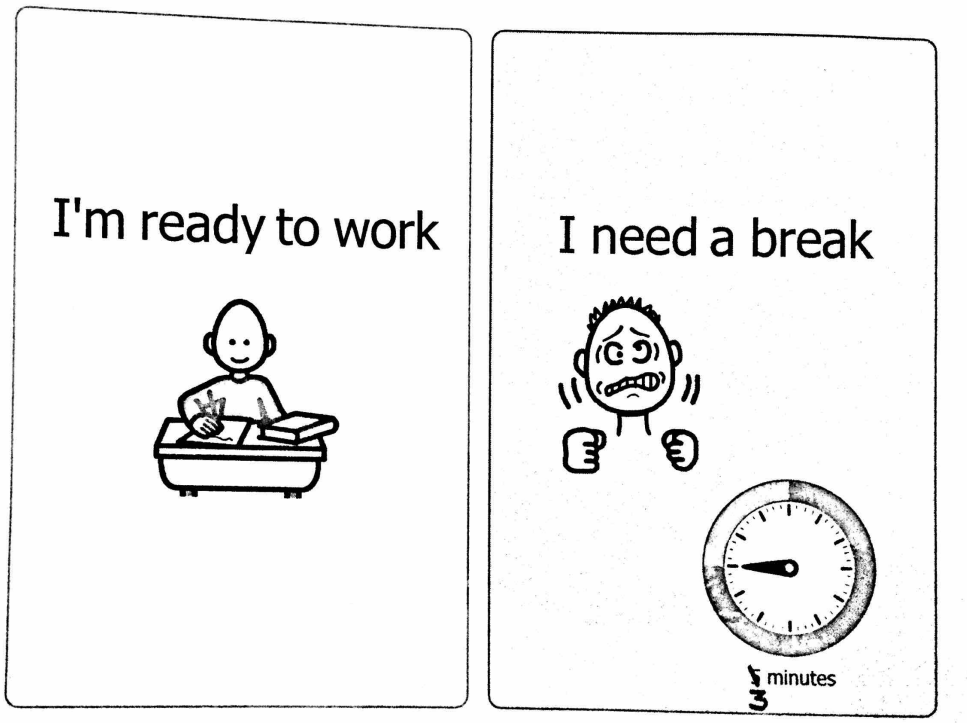


Figure 6 Social story used for the first 10 sessions for each participant

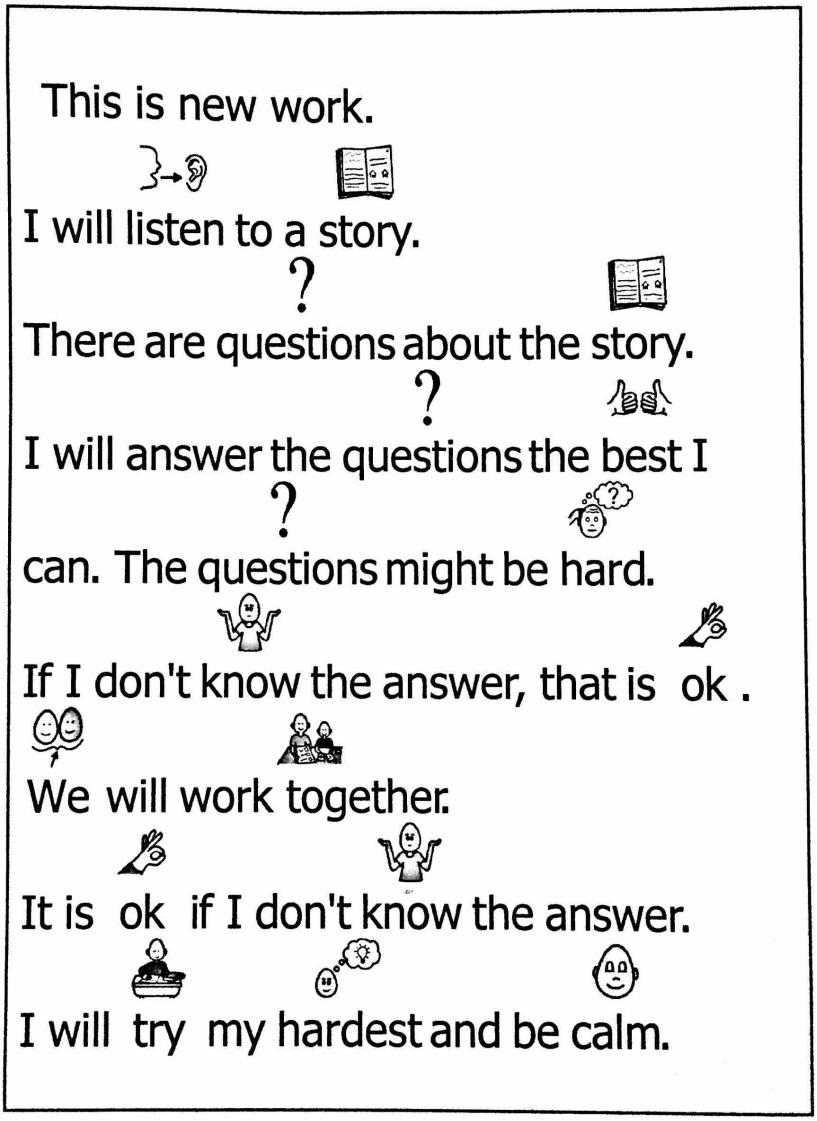


Figure 7 Social validity questionnaire for teachers and instructional assistants

Condition 1: Speech

1. For the lesson using **speech only**, how confident are you that you could implement this lesson successfully?

Least 1 2 3 4 5 Most

2. If this is the most therapeutic intervention condition, how willing are you to continue to deliver lessons using this method?

Least 1 2 3 4 5 Most

Condition 2: Simultaneous Communication

1. For the lesson using **simultaneous communication**, how confident are you that you could implement this lesson successfully?

Least 1 2 3 4 5 Most

2. If this is the most therapeutic intervention condition, how willing are you to continue to deliver lessons using this method?

Least 1 2 3 4 5 Most

Condition 3: Sandwiching

1. For the lesson using **sandwiching**, how confident are you that you could implement this lesson successfully?

Least 1 2 3 4 5 Most

2. If this is the most therapeutic intervention condition, how willing are you to continue to deliver lessons using this method?

Least 1 2 3 4 5 Most

Condition 4: Sign Only

1. For the lesson using **sign only**, how confident are you that you could implement this lesson successfully?

Least 1 2 3 4 5 Most

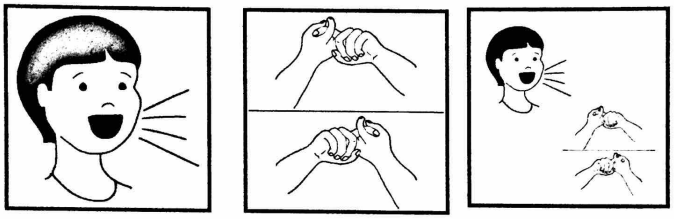
2. If this is the most therapeutic intervention condition, how willing are you to continue to deliver lessons using this method?

Least 1 2 3 4 5 Most

Figure 8 Social validity questionnaire for participants

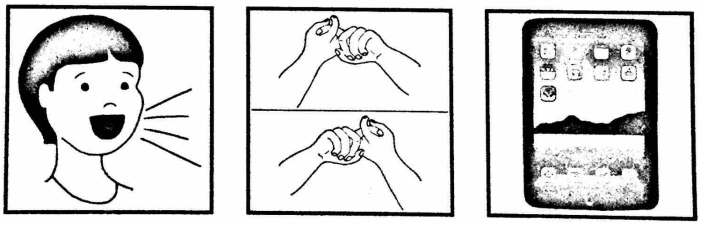
Participant Preference Assessment

1. When you hear a story, do you like it to be read out loud, told using sign language, or both?



Speech **Sign Language** **Both**

2. When you have something to say, do you like to say it with your voice, with sign language, or using your device?



Speech **Sign Language** **Device**

Figure 9 Correct responding across conditions by Anna

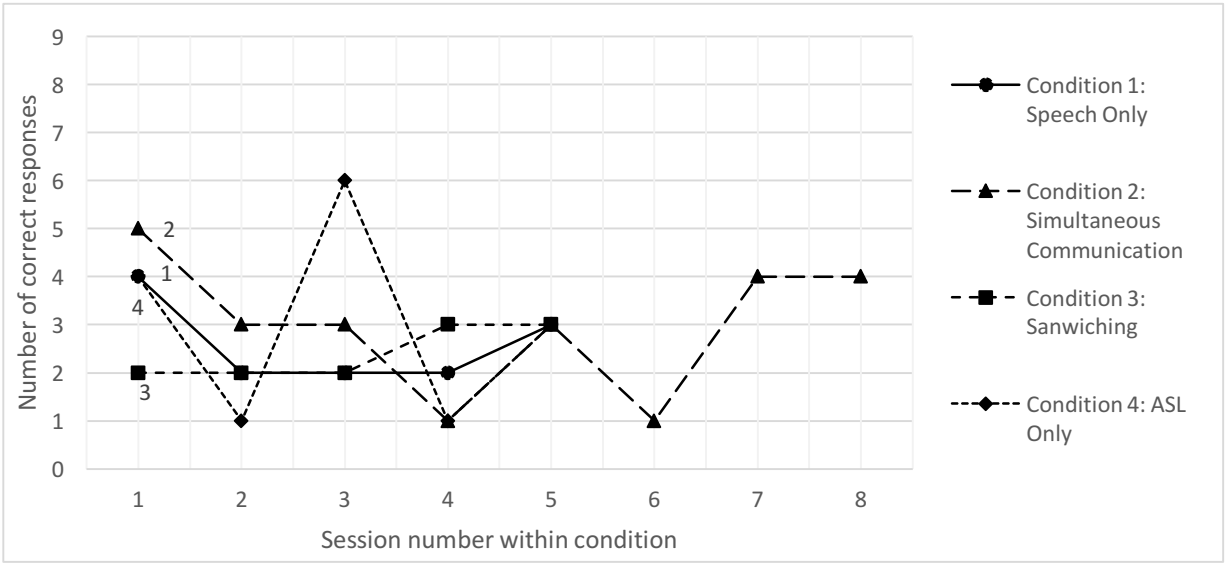


Figure 10 Correct responding across conditions by Ben

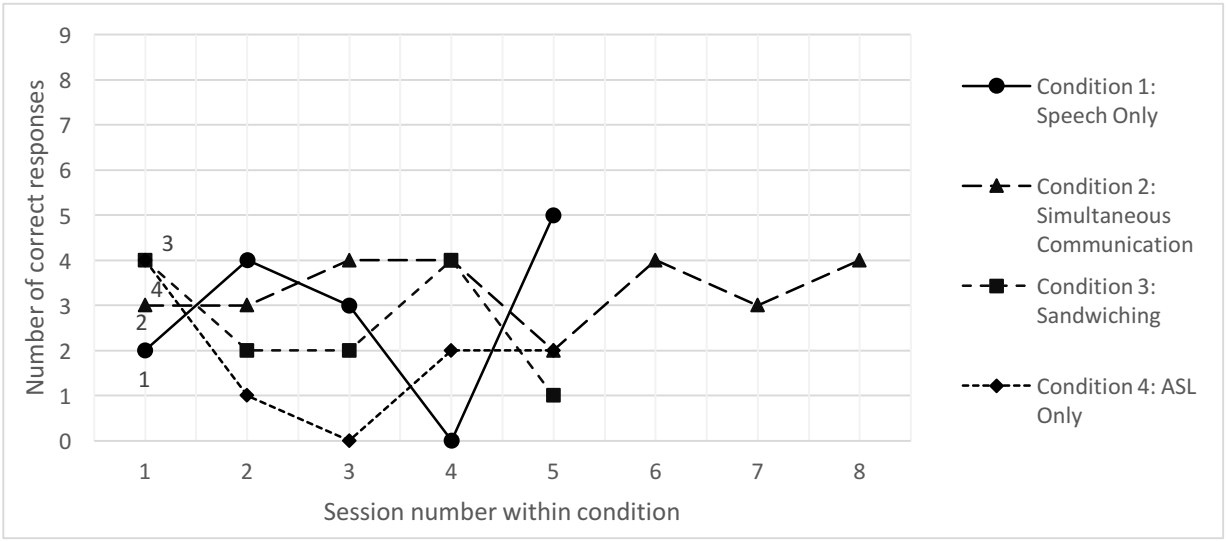


Figure 11 Correct responding across conditions by Christopher

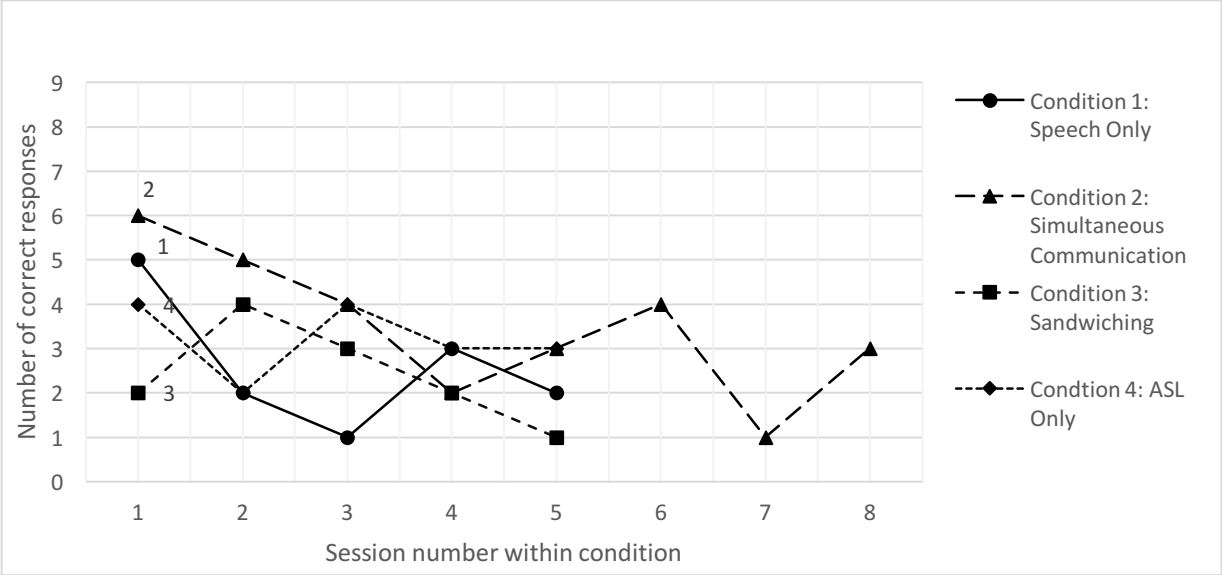
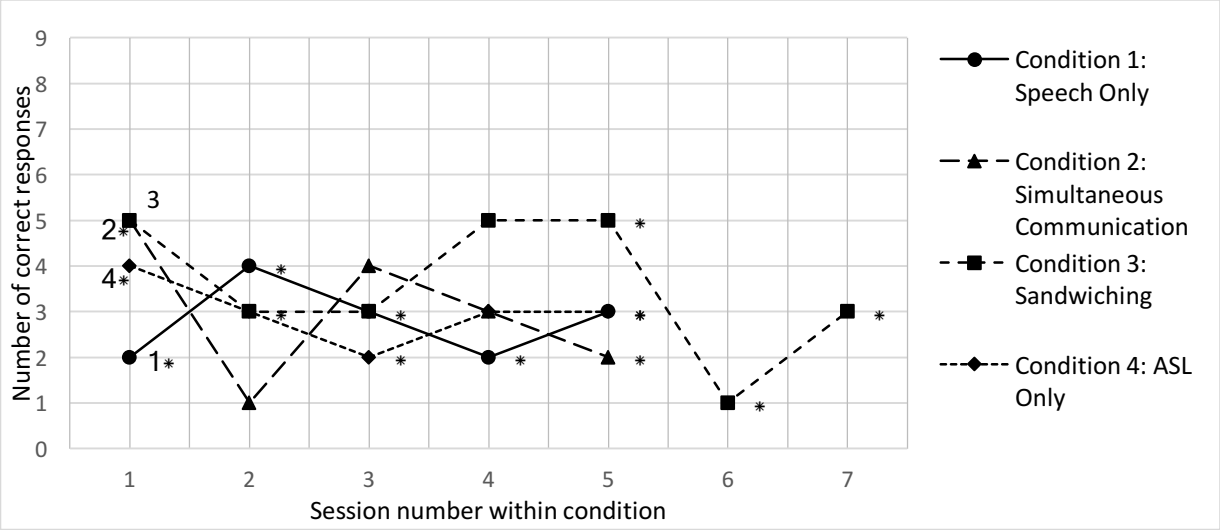


Figure 12 Correct responding across conditions by Dominic



*Stars indicate lessons in which Dominic selected the last answer presented for every question in that session

Figure 13 Procedural fidelity protocol for observers

1. Sign name at top of data sheet
2. Intervention conditions for the 3 target words of that lesson
   - 1 = speech only
   - 2 = Simultaneous speech & sign
   - 3 = sandwiched (sign-speech-sign)
   - 4 = sign only
3. If a target word is said using the **incorrect condition** for that lesson/summary (condition specified at the top of data sheet), **CIRCLE the step number. Example:**

1. Read first part of text to participant. **2. Comprehension check:** ANSWER	2. **Response:** **+** **--** **Response Modality:** **sp** **sgd** **sign** **phys**

   - All questions are speech only.
4. If the step is **skipped,** mark an **X over the step number. Example:**

1. Read first part of text to participant. **2. Comprehension check:** ANSWER	2. **Response:** **+** **--** **Response Modality:** **sp** **sgd** **sign** **phys**

5. If the student answers a question **CORRECT, circle +.** If the student answers a question **INCORRECT, circle -. Example:** * first answer

1. Read first part of text to participant. **2. Comprehension check:** ANSWER	2. **Response:** **+** **--** **Response Modality:** **sp** **sgd** **sign** **phys**

6. If the student responds to a question in any way **besides pointing / ordering cards, CIRCLE** the response modality (speech, device, sign, gesture). **Example:**

2. Read first part of text to participant. **2. Comprehension check:** ANSWER	2. **Response:** **+** **--** **Response Modality:** **sp** **sgd** **sign** **phys**