Using Simultaneous Prompting and Computer-Assisted Instruction to Teach Story Writing to Students with Autism

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Abstract: In the current study, the researchers evaluated the effects of simultaneous prompting and computer-assisted instruction on the story-writing responses of 3 males with autism, 7 to 10 years of age. Classroom teachers conducted all probe and training sessions. The researchers used a multiple baseline across participants design to evaluate the efficacy of the intervention. In addition, they used pre-posttest measures to assess the generalization of acquired skills across untrained story topics and different response topographies. The data indicated that simultaneous prompting and computer-assisted instruction were effective in improving the story-writing skills of all 3 participants. Two of the participants demonstrated maintenance and generalization of trained responses.

Keywords: Autism, Written expression, Simultaneous prompting, Computer-assisted instruction

Introduction

Written expression is a fundamental skill for individuals in educational and community contexts. In schools, students use written language to demonstrate their acquisition of content (Mercer & Mercer, 2005). Upon graduation, students are expected to write proficiently across purposes and for a variety of audiences. In community contexts, the utility of written communication extends to almost every facet of daily life. Employers increasingly demand that applicants demonstrate proficient writing skills upon entry to the workforce (National Commission on Writing, 2004). Social networks now require that members interact via electronic written messages (e.g., e-mail, texts, *Facebook*©). Finally, people have come to rely on a variety of text-based tools (e.g., PDA, smart phone apps, planners) to document and organize their lives.

Addressing Written Expression in Students with Autism

Unfortunately, researchers have suggested that individuals with autism spectrum disorders (ASD) may have difficulty acquiring writing skills (Gabig, 2008; Myles, Huggins, Rome-Lake, Barnhill, & Griswold, 2003). This is especially problematic in light of data indicating that many students with ASD acquire a limited range of vocal communication skills (Miranda-Linne & Melin, 1997). Fortunately, researchers have demonstrated that written text can effectively replace or augment vocal communication. In

an early study, LaVigna (1977) demonstrated that students with autism could make requests by exchanging cards depicting written texts for preferred items. Researchers also have reported an improved quality in the conversation of individuals with ASD when they are given the opportunity to type communicative responses (Forsey, Bird, & Bedrosian, 1996; Schairer & Nelson, 1996).

Despite the importance of acquiring writing skills for students with ASD, there has been limited research in the area of teaching writing to these students. The majority of research in the area of written expression has focused on spelling responses. Stromer, MacKay, Howell, and McVay (1996) evaluated the effects of computer-assisted instruction (CAI) and delayed word construction procedures on the spelling performance of a 21-year-old male with ASD. They demonstrated that the intervention was effective and that the participant generalized spelling skills to handwritten responses. Sugasawara and Yamamoto (2007) used CAI to teach the construction of Japanese characters to a 4-year-old male with pervasive developmental disorder. The student acquired the target responses and also demonstrated gains in vocal reading of the characters. Kinney, Vedora, and Stromer (2003) reported that the computer presentation of video clips depicting an adult modeling correct spelling responses was effective in teaching an 8-year-old female with autism to spell trained and untrained words. Finally, two research teams evaluated the effects of using a copy-and-cover method (Cuvo, Ashley, Marso, Zhang, & Fry, 1995) and a voice output communication aid to 5 children with autism, ages 9 to 12 years. In addition, both teams compared feedback conditions (i.e., print, speech, print + speech) and found differential effects on measures of efficiency across the participants (Schlosser & Blischak, 2004; Schlosser, Blischak, Belfiore, Bartley, & Barnett, 1998).

Two investigations have addressed the development of basic expository writing responses. Basil and Reyes (2003) evaluated the effects of a computerized software package (i.e., *Delta Messages*; Nelson & Heimann, 1995) on the sentence construction skills of 2 students with autism, ages 8 and 14 years. Both students acquired targeted responses, but one of the students demonstrated additional gains in handwritten responses and on measures of phonological awareness. Yamamoto and Miya (1999) also used CAI to teach sentence construction tasks to students with ASD. Three students, ranging in age from 6 to 10 years, acquired computer-based target responses, but also demonstrated generalized gains across handwritten and vocal topographies.

Five teams of researchers have evaluated complex writing responses. Rousseau, Krantz, Poulson, Kitson, and McClannahan (1994) used a sentence-combining technique to increase the use of adjectives for 3 males with ASD, ages 11 to 13 years. Bedrosian, Lasker, Speidel, and Politsch (2003) used a multi-component intervention package to increase the number of words used, peer interactions, and revisions made during the joint writing activities of a 14-year-old male with ASD and a peer without disabilities. The package, which consisted of the use of an assistive augmentative communication device, story maps, storyboards, and adult modeling, was effective in improving the participant's narrative writings skills. Delano (2007a, 2007b) conducted two studies investigating the use of self-regulated strategy development procedures (SRSD; Graham, Harris, McArthur, & Schwartz, 1991) to improve the narrative writings skills of students with Asperger's syndrome (AS). In the first investigation, Delano used video self-modeling of the SRSD strategies to increase the number of words and functional elements used by 3 males with AS, ages 13 to 17 years, in persuasive writing compositions. The

students demonstrated gains in target responses but also generalized their newly acquired skills to expository writing. In the second investigation, Delano used a preference interview and SRSD to increase the use of action words, describing words, and revisions by a 12-year-old male with AS during story writing activities. The participant demonstrated gains across all measures. Finally, Asaro and Saddler (2009) investigated the use of SRSD during instruction of a 10-year-old male with AS. They delivered scaffolded instruction across seven lessons designed to teach the participant strategies for planning and revision. Following intervention, the participant demonstrated gains in the number of story elements used and on measures of overall writing quality.

Incorporating Response Prompting Procedures during Instruction

The majority of the articles described the use of various prompts to elicit student responses, but many failed to provide operationalized procedures for the delivery of those prompts. Response prompting procedures serve as a critical component of instruction for students with disabilities and have been evaluated and refined through a wide body of research (Morse & Schuster, 2004; Schuster, Morse, Ault, Doyle, Crawford, & Wolery, 1998; Walker, 2008). One of the most recent innovations in response prompting procedures has been the development of simultaneous prompting (SP; Gibson & Schuster, 1992). Simultaneous prompting involves the consistent delivery of a controlling prompt immediately following the presentation of the discriminative stimulus (e.g., task directive). In other words, during all instructional trials, a prompt is provided that ensures the student will produce a correct response. Additionally, since the student is never given the opportunity to respond without the prompt, transfer of stimulus control is assessed in probe trials that precede training trials on each day of instruction (Schuster, Griffen, & Wolery, 1992). Simultaneous prompting has been effective in the instruction of a wide range of skills to a heterogeneous group of students (Morse & Schuster). Recently, data from several studies have indicated that SP is effective during the instruction of students with ASD (Akmanoglu & Batu, 2004; Akmanoglu-Uludag, & Batu, 2005; Kurt & Tekin-Iftar, 2008). To date, SP has never been evaluated in the context of writing instruction for students with ASD.

Application of Computer-Assisted Instruction

In addition, the majority of research teams used CAI as a component of writing intervention for students with ASD. Computer-assisted instruction refers to the use of a computer-technology as a learning medium that presents learning materials and/or check's learner's knowledge (Anohina, 2005). Several researchers have suggested that CAI is compatible with the characteristics of individuals with ASD (Higgins & Boone, 1996; Moore, McGrath, & Thorpe, 2000). For example, during CAI, learners with ASD have access to controlled presentations of relevant instructional stimuli while simultaneous avoiding many of the social communicative demands associated with traditional instruction. Though a growing body of research supports the promise of CAI for students with ASD, there are limited data demonstrating its efficacy during writing instruction for this population (Pennington, 2010).

In the current study, the researcher addressed two questions. First, to what extent is SP effective in teaching students with ASD to construct computer-based stories? Second, to what extent do students generalize skills acquired through the use of SP and CAI to untrained story topics and across different response topographies (i.e., vocal, handwriting)?

Method

Participants

Students. The participants attended a school located in a large metropolitan district in which the one of the authors had served previously as an autism resource teacher. The authors contacted the teacher, and she identified potential participants. The participants were selected following the screening procedures described below. Three males ranging in age from 7 to 10 years with autism participated. All 3 participants received special education services in self-contained classrooms for children with ASD. In addition, they received school-based speech-language and occupational therapy services. Their individualized educational programs contained goals related to communication, literacy, functional mathematics, and the reduction of aberrant behaviors. Paul was a 7-year-old white male with autism. He scored a 35 on the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988) and a 43 on the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983). These were the most current scores available from the school system. Paul's individualized education program addressed writing 4- to 5-word sentences, writing three sentences about a topic, answering 'wh' questions, and counting money. Paul's teacher reported that he demonstrated strengths in task initiation, early academic skills, requesting, and computer skills. His weaknesses were in on-task behavior, generative writing, and vocal communication.

Caleb was a 10-year-old white male with autism. He scored a 39 on the CARS. No other assessment data were available in his records. Caleb's individualized education program addressed reading sight words, requesting help, counting coins, and sequencing three events. Caleb's teacher reported that he demonstrated strengths in basic academic concepts (i.e., number, letter, and object identification), computer skills, and adaptive skills. Caleb's weaknesses were in compliance, generative writing, and vocal communication,

Jason was an 8-year-old white male with autism. He scored a 30 on the CARS and a 65 on the Battelle Developmental Inventory (BDI; Newborg et al., 1984). Jason's individualized education program addressed reading sight words, identifying the larger number, completing work, and making requests for preferred activities. Jason's teacher reported that he demonstrated strengths in following simple directions and basic academic concepts. Jason demonstrated weaknesses in on-task behavior, generative writing, and vocal communication.

Instructors. Two classroom teachers conducted all sessions. The first had a Master's degree in special education and 8 years of experience teaching individuals with ASD. She had extensive experience in using response prompting procedures and CAI. After the first two participants reached criterion, the first teacher left on a maternity leave and was replaced by a substitute teacher. The second teacher had a Master's degree in special education and 30 years of experience working with individuals with moderate to severe disabilities and ASD. She also had previous experience using response prompting procedures.

Others. The researcher provided all teacher trainings and collected reliability data. The researcher had a doctoral degree in special education and 14 years of teaching experience. In addition, the researcher had extensive experience in using response prompting procedures and CAI to teach students with ASD.

Settings and Arrangement

The classroom teachers conducted all sessions in a 1:1 format within a self-contained classroom for children with ASD. The classroom staff consisted of 1 teacher and 2 teacher assistants. Six students, ranging in age from 6 to 11 years, attended the classroom. Sessions occurred daily with the exception of student or teacher absences. Sessions lasted approximately 5 to 10 min. The classroom teacher placed a laptop computer in the back corner of the classroom on a 55 x120 cm rectangular table. The teacher and the student sat next to each other, facing the laptop, with their backs to the rest of the class. A felt screen blocked other students from approaching the instructional area. During all sessions, paraprofessionals delivered instruction to the remaining five students.

Materials

The classroom teacher conducted all sessions on an IBM personal computer. The computer was equipped with a touch screen and *Clicker 5*™ (Crick Software, Inc., 2005) software. The researcher used *Clicker 5*™ to create three story templates to use during instruction and one template that remained as an untrained stimulus to test generalization. The templates consisted of cells containing one word. Cells containing non-subject nouns also contained pictures (i.e., color line drawings).

The researcher arranged the cells into four vertical columns by subjects, articles, verbs, and objects. An example of a template is in Figure 1. The researcher used an Olympus WS-300M voice recorder to record vocal generalization probes. One student, Caleb, used a word processor to type his responses during the writing generalization probe. His teacher reported that he typically used a word

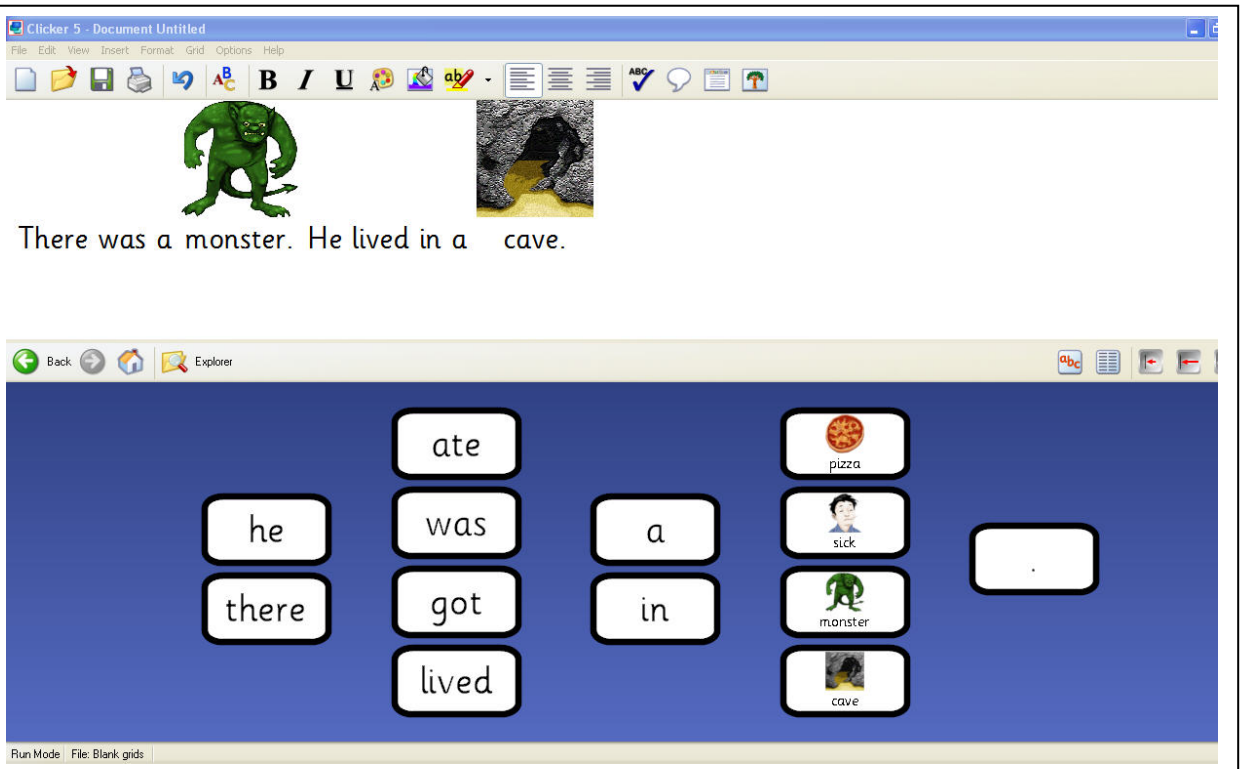

Figure 1. Example of story template developed on *Clicker 5*™.

processor during writing activities due to fine motor skill deficits.

General Procedures

The researcher trained a classroom teacher to use a SP procedure to teach 3 students to write a story using *Clicker 5™*. The classroom teacher conducted all probe and training sessions at approximately the same time each morning. Each session consisted of a single daily probe in which the teacher randomly presented one of three story templates. The teacher then delivered instruction on three story templates in random order.

To assess generalization, the researcher presented a fourth story template to 2 of the participants before and after training conditions. This template remained untrained during the investigation. In addition, the researcher conducted story-telling and story-writing probes prior to and following instruction for 2 of the students.

Screening

The researcher informally assessed four students to determine if they had the prerequisite skills for participation in the study. The assessment consisted of a teacher interview, classroom observation, and one session of direct testing. One student did not meet the prerequisite of staying in the instructional area for at least 10 min and as a result, did not participate in the study. During direct testing, the teacher asked the students to touch a cell on the computer screen. If the student touched the cell within 5 s, he was considered to have the prerequisite skill of touching an isolated area (approximately 1.5 cm2) on a computer screen. Three students met the inclusion criteria of being able to (a) stay in an instructional area for 10 min; (b) follow verbal one-step directions; (c) respond following a gestural point prompt; and (d) demonstrate the ability to touch an isolated area (approximately 1.5 cm^2) on a computer screen.

In addition, the researcher and classroom teacher screened the students to ensure that they did not already possess the skills targeted for instruction. During screening, the teacher presented each of the 4 story-writing templates and presented the request, "Write a story." The teacher waited 90 s for the student to respond. If a participant constructed at least one sentence using a particular template then it would not be used in the study to ensure help ensure the tasks were equally novel across participants.

Teacher Training

The researcher trained the primary teacher across several days. On the first training session, the researcher described the purpose of the study and outlined the general procedures. The researcher then sent the written instructional procedures to the teacher via e-mail. During the second training session, the researcher reviewed, answered questions related to, and subsequently modeled the procedures. The researcher then observed the classroom teacher performing the probe and instructional procedures and delivered feedback. On the final day, the researcher observed the teacher during initial instruction with the participants.

Task Analysis

The researcher developed a task analysis of the steps required to complete the story-writing task. Each step consisted of the construction of a single sentence. Each story was comprised of 4 sentences that were to be completed in a prescribed order. The first sentence in each story introduced a character (i.e., There was a monster.). The second introduced a setting (i.e., He lived in a cave.). In the third sentence, the character performed an action (i.e., He ate a pizza.). Finally, the

fourth sentence described a resulting action or consequence (i.e., He got sick).

Baseline/Probe Procedures

Full probe. The teacher conducted full probe sessions across all participants prior to the beginning of the study. In addition, she conducted full probe sessions prior to initiating training for the second and third participants. Each full probe condition lasted a minimum of 3 sessions. During each full probe session, the teacher randomly selected one of the three story-writing templates and opened it on the computer desktop. The teacher stated the student's name and waited for his attention. Then she delivered the task directive, "Write a story" and waited 5 s for the student to respond. The teacher used a multiple opportunity format. If the student selected a cell out of the prescribed order or did not respond within 5 s, the screen was covered with a white board and the teacher constructed the sentence. The teacher then delivered the vocal directive, "Keep going" and waited 5 s for the student to write the next sentence. These steps were repeated for all 4 sentences.

The researcher defined a correct response as starting sentence construction within 5 s, constructing a complete sentence, and constructing the sentence in the prescribed order within the story. Incorrect responses were defined as (a) not initiating the sentence within 5 s following the task directive or the completion of the previous sentence, (b) not selecting the next word in a sentence within 5 s of the selecting the previous word, (c) writing the words in the sentences out of prescribed order, and (d) omitting a word in the sentence.

Daily probes. The teacher conducted a daily probe prior to story writing instruction. Daily probes were conducted using procedures identical to those during full probe sessions.

Simultaneous Prompting

During training, the teacher randomly selected a computer template and opened it on the computer desktop. The teacher delivered an attentional cue by saying the student's name or the directive, "Look." Once the student was oriented towards the computer screen, the teacher delivered the directive, "Write a story" immediately followed by a controlling prompt (i.e., pointing to each cell). The teacher waited 5 s for the student to select each cell following the teacher prompt. The teacher delivered descriptive verbal praise following the student's construction of each sentence. The teacher continued to prompt word selection until the student had completed the story. Upon completion, the teacher selected the playback button and the computer provided auditory feedback (i.e., reading of the story). During training, the teacher presented all three templates in random order.

Maintenance Procedures

The teacher conducted maintenance probes for 2 of the participants using procedures identical to full and daily probe sessions. The school year ended prior to the third student's meeting of the criterion for acquisition of the targeted skill. The teacher conducted maintenance probe sessions on the 10th and 28th day following criterion for Paul. For Caleb, maintenance probes were administered at 12 and 32 days following acquisition.

Generalization Procedures

The researcher conducted three sets of generalization probes. First, the researcher assessed the generalization of story writing skills to a novel story template. Second, the researcher assessed generalization across two response topographies (i.e., vocal response, handwriting).

The researchers assessed the generalization of skills to untrained stimuli using pre -posttest procedures. Prior to instruction, the classroom teacher presented a fourth story template to each student using procedures identical to those used during daily probe sessions. This story template remained untrained throughout instructional conditions. Following the meeting of criterion by each student, the researcher presented the untrained story template as it was presented prior to instruction. The researcher then compared the number of words and sentences generated in pretest and posttest measures.

The researchers assessed the generalization of skills across response topographies using pre-posttest procedures. Prior to instruction, the researcher asked each of the students to first tell and then write a story. The researcher recorded the number of words and sentences generated during the pretest. Following training, the researcher conducted a posttest using identical procedures. The researcher compared the number of words and sentences generated in pretest to posttest responses.

Experimental Design

The researcher used a multiple probe (MP) design across participants to evaluate the effects of SP and CAI on generative story writing. The researcher selected the MP design for its ability to limit threats to internal validity that may be present in instructional settings. The delayed introduction of an intervention across three tiers reduced history threats related to general intervention in special education classroom settings and maturation threats involving the typical development of young children (Gast, 2010).

Reliability

The researcher collected reliability data on both dependent and independent variables. During reliability data collection, the researcher sat behind the teacher and student while recording responses on a data sheet. The researcher calculated inter-observer agreement (IOA) by dividing the number of agreements by the sum of agreements and disagreements and then multiplying by 100 (Gast, 2010). Inter-observer agreement data collection occurred at least once per baseline, training, maintenance, and generalization conditions for two of the participants. Since Jason did not reach criterion, IOA was collected at least once per baseline and training conditions. For Paul, the researcher collected IOA data on 33% of baseline probes, 11% of probes during training conditions, 100% of generalization probes, and 50% of maintenance probes. For Caleb, the researcher collected data on 33% of baseline probes, 22% of daily probes during training conditions, 50% of generalization probes, and 50% of maintenance probes. For Jason, interobserver agreement data collection occurred during 25% of baseline probes and 16% of daily probes during training conditions. Overall, agreements for Paul, Caleb, and Jason were 100%, 100%, and 100%, respectively.

The researcher also collected independent variable reliability data for each participant at least twice per condition. For Jason, data were collected during training and baseline sessions. Procedural reliability was calculated by dividing the number of observed teacher behaviors by the number of planned teacher behaviors and the multiplying by 100 (Gast, 2010). The researcher assessed the performance of 14 teacher behaviors (e.g., delivery of attention prompt, points to each word and waits 5 s for student to respond, praises correct responses). For Paul and Caleb, independent reliability data indicated levels of accuracy to be 100% and 92%, respectively. For Jason, accuracy was calculated to be 95%.

Results

Two of the 3 participants reached criterion using the SP procedure (see Figure 2). Additionally, both participants demonstrated some generalized responses across novel stimuli and response topographies. One participant demonstrated noticeable improvement, but his training condition was terminated due to the end of the school year. As a result, the researchers did not conduct analyses of generalization and maintenance.

Paul. During baseline sessions, Paul constructed 0% of the stories using Clicker5 software. During the instructional phase, Paul reached the criterion within 9 sessions. The researchers conducted maintenance probe sessions 2 and 4 weeks following training. Paul constructed 100% of the prescribed

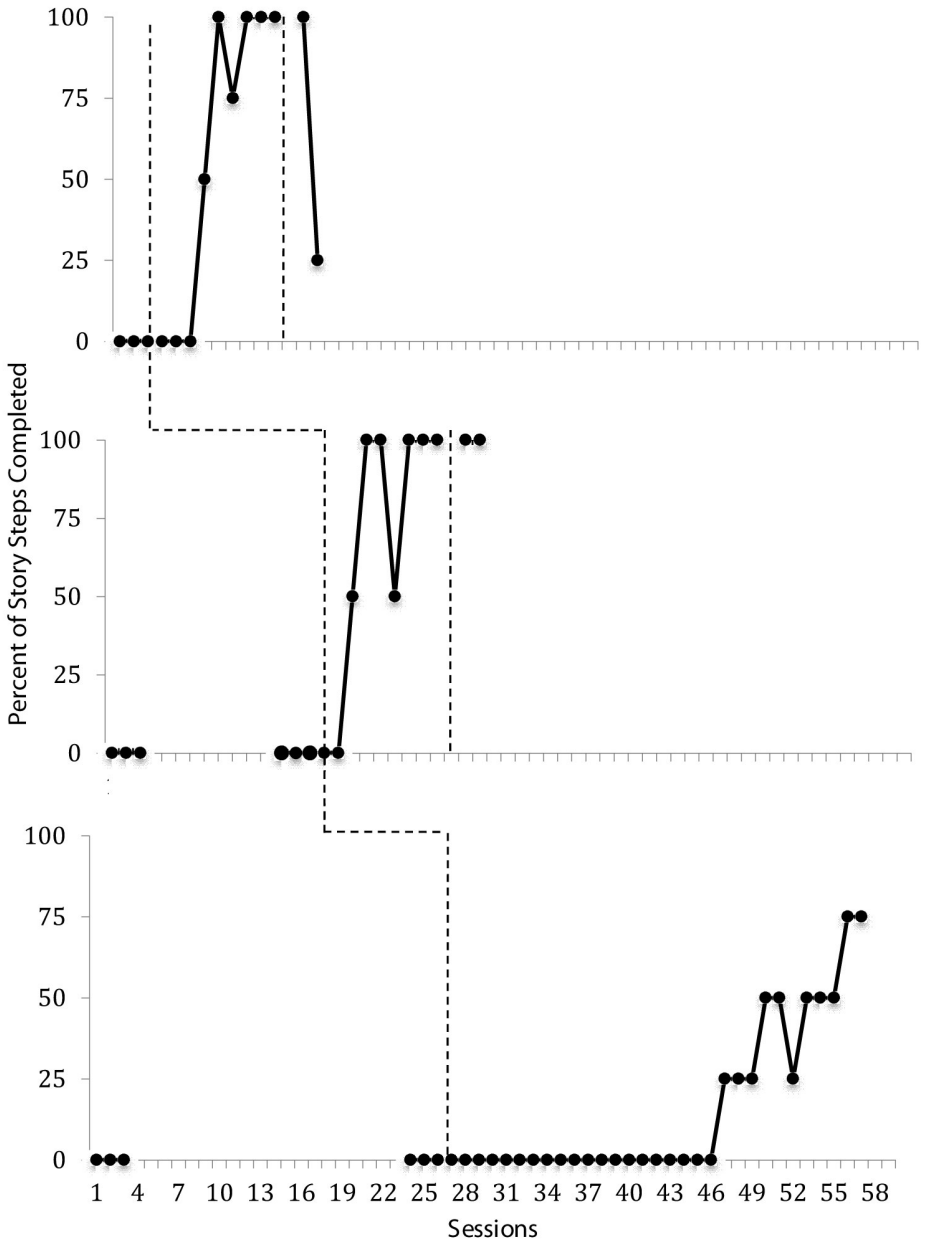

Figure 2. Student performance of computer-based story-writing tasks.

sentences at 2 weeks. At 4 weeks, Paul was able to construct four related sentences (i.e., 'There was alien,' 'He lived in space,' 'He ate popsicles,' 'He visited earth'), but only 25% of the steps were scored as correct due to article omissions and sentence order errors. As depicted in Table 1, Paul generated no words or sentences during the generalization pretest on a novel story template. Following training on the generalization posttest, Paul constructed two sentences and three additional words (i.e., 'There was a robot,' 'He flew in a space rocket, a rocket, high'). During the writing pretest, Paul constructed two unrelated sentences consisting of a total of seven words. Following training, he wrote four related sentences consisting of 16 words.

During the vocalization pretest, Paul spoke seven words in response to the teacher directive, "Tell me a story" (i.e., "fable, seventeen, My name is a Fat"). Following training, Paul spoke 16 words (i.e., "There was a king, He lived in a castle, He saved a princess, He got married").

Caleb. During baseline, Caleb constructed 0% of a story using *Clicker 5*™ software. During the instructional phase, Caleb also reached the criterion within 9 sessions. The researchers conducted maintenance probe sessions 2 and 4 weeks following training. Caleb constructed 100% of a story during both sessions. During the generalization pretest on a novel story template, Caleb generated 0 sentences and words. Following training on the generalization posttest, Caleb constructed four sentences consisting of 16 words (i.e., 'There was an alien,' 'He lived in a rocket,' 'He lived in space,' 'He built high'). During the writing pretest, Caleb wrote no words. Following instruction, he generated four words (i.e., 'king,' 'castle,' 'princess,' 'married').

During the vocalization pretest, Caleb spoke one word in response to the teacher directive, "Tell me a story" (i.e., "there"). Following training, Caleb spoke 41 words:

> I'll show you a story, I read a story about a king, This story is about an alien, This story is about when a king tried to live in a castle, The king saved a princess, So he got married.

Jason. During baseline, Jason constructed 0% of a story using *Clicker 5*™ software. During

Table 1
Number of Words and Sentences in Pretest and Posttest Responses

Student Variables	*N* words		*N* Sentences	
	Pretest	Posttest	Pretest	Posttest
Paul				
Novel CAI template	0	13	0	2
Written responses	7	16	2 (Unrelated)	4
Vocal response	7	16	1	4
Caleb				
Novel CAI template	0	16	0	4
Written responses	0	4	0	0
Vocal response	1	41	0	6

the instructional phase, Caleb constructed 75% of a story using the computer-based templates. Instruction occurred across 31 sessions but was terminated at the end of the school year.

Outcomes and Benefits

In general, the researchers demonstrated that the use of SP was effective in teaching participants to construct simple stories. Following training, all of the participants demonstrated gains in computer-based story construction responses. Two of the participants performed to criterion levels and one participant reached 75% of criterion prior to the termination of the study at the end of the school year. In addition, two of the participants demonstrated varying degrees of generalization and maintenance across novel story templates and response topographies

Several findings warrant further discussion. First, both Paul and Casey demonstrated generalization from computer-based construction tasks to vocal responses. Impairment in vocal communication is a cardinal feature of autism, thus any intervention that increases vocal behavior is compelling. It also is important to note that vocal communication was not targeted for instruction during the intervention. This suggests that the intervention was efficient in that it may have resulted in the acquisition of non-targeted behaviors. Further analysis of these preliminary findings is warranted.

Second, it should be noted that the participants might have demonstrated performance that was not captured by the data. The researcher used stringent response criteria that were not sensitive to the generation of thought units (Hunt, 1965). A thought unit (T-unit) is a word or set of words that express an independent idea or concept. Educators have used the number of T-units to evaluate the development of their students' writing skills (Rousseau et al., 1994). The participants in the current study generated T-units prior to the accurate construction of targeted sentences. For example, Jason consistently generated thought units related to the target stimulus after 7 dys of training (i.e., "There was castle"). Additionally, Paul generated four T-units related to the target stimulus 4 wks following training, though his data indicated that he only constructed one correct sentence.

Finally, the use of CAI and SP required minimal instructional time. Training sessions lasted approximately 5 min. This is critical in that many young children with ASD may not have the prerequisite skills to engage in instructional activities for long periods of time. Simultaneous prompting is a valuable tool for educators working with students that use assistive technology. Since it involves the application of a prompt that ensures that the student will respond correctly upon first application, instructors may instruct students on the technical aspects of how to use the technology (i.e., operational competence) while simultaneously teaching a target skill. In the current analysis, instruction towards operational competence was embedded within the steps of the task analysis. For example, step 1 required the student to select a cell in the correct order and to do so within 5 s. Therefore, the motor and fluency aspects of the response were taught at the same time as the cognitive aspects of the writing task (Light, Beukelman, & Riechle, 2003). Additionally, SP is simplistic in that it does not require instructors to consider a hierarchy of prompts or to adjust prompt delay intervals during instructional conditions. This reduced complexity may be especially useful to instructors when introducing instruction in the context of new technologies.

Limitations

Several limitations should be noted. First, the researcher did not acquire the recommended three replications of the treatment effects. The school year concluded prior to the end of the study and the researchers terminated training for Jacob. Second, the introduction of the substitute teacher may have contributed to Jason's slow progress during training and should be considered a weakness of the current study. Jason's rates of correct responding might have been affected by a lack of rapport with the substitute teacher, the teacher's limited experience in using CAI, or a failure to generalize instructional behaviors to the novel staff person. Third, the researchers did not assess the students' ability to read the words used in story writing tasks prior to instruction. Differences in student's rates of acquisition may have been related to their reading ability. Finally, the repeated presentation of only three different story templates may have contributed to the participants' acquisition of story writing responses. Future researchers should investigate the effects of more varied and complex templates on the acquisition of student responses.

Future Research

The findings of this preliminary study suggest that SP and CAI were useful during the instruction of story writing for students with ASD. Future research should address the effects of SP and CAI on other writing skills. For instance, investigators might consider evaluating *Clicker 5*™ during instruction on writing personal narratives, or nonfiction pieces related to grade-level core content. Researchers also might investigate the use of selection-based writing technologies for use by individuals with ASD during e-mail and text messaging correspondence.

There are several variables within *Clicker 5*™ that should be investigated. First, researchers should compare the effects of the pictures used during selection-based writing interventions. Research has indicated that pictures paired with sight words may serve to block their acquisition (Didden, Prinsen, & Sigafoos, 2000). It should be empirically validated whether pictures have the same effects during writing instruction. In addition, researchers need to determine the best arrangements for words/symbols in selection-based writing programs. In the current study, the researcher embedded intra-stimulus prompts within the templates. Word choices for sentence completion were arranged from left to right and in order of subject, verb, and predicate. Future researchers should look at the effects of randomly arranging words/symbols within arrays of choices on the generalization of writing skills.

Finally, it has been noted that students' reading ability was not assessed prior to instruction. Researchers should investigate the impact of reading ability on the generation of story responses for students with ASD. In addition, researchers should evaluate to what extent reading responses can be acquired through observational learning during computer assisted story-writing instruction.

References

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

Akmanoglu-Uludag, N., & Batu, S. (2005). Teaching naming to individuals with autism using simultaneous prompting. *Education and Training in Developmental Disabilities, 40*, 401-410.

Anohina, A. (2005). Analysis of the terminology used in the field of virtual learning. *Journal of Educational Technology and Society, 8*, 91-102.

Asaro, K., & Saddler, B. (2009). Effects of planning instruction on a young writer with Asperger syndrome. *Intervention in School and Clinic, 44*, 268-275.

Basil, C., & Reyes, S. (2003). Acquisition of literacy skills by children with severe disability. *Child Language Teaching and Therapy, 19*, 27-49.

Bedrosian, J., Lasker, J., Speidel, K., & Politsch, A. (2003). Enhancing the written narrative skills of AAC students with autism: Evidence-based research issues. *Topics in Language Disorders, 23*, 305-324.

Crick Software, Inc. (2005). Clicker5™ [Computer software]. Wesport, CT: Author.

Cuvo, A. J., Ashley, K. M., Marso, K. J., Zhang, B. L., & Fry, T. A. (1995). Effect of response practice variable on learning spelling and sight vocabulary. *Journal of Applied Behavior Analysis, 8*, 155-173.

Delano, M. E. (2007a). Improving written language performance of adolescents with Asperger syndrome. *Journal of Applied Behavior Analysis, 40*, 345-351.

Delano, M. E. (2007b). Use of strategy instruction to improve the story writing skills of a student with Asperger syndrome. *Focus on Autism and Other Developmental Disabilities, 22*, 252-258.

Didden, R., Prinsen, H., & Sigafoos, J. (2000). The blocking effect of pictorial prompts on sight-word reading. *Journal of Applied Behavior Analysis, 33*, 317-320.

Forsey, J., Bird, E. K., & Bedrosian, J. (1996). Brief report: The effects of typed and spoken modality combinations on the language performance of adults with autism. *Journal of Autism and Developmental Disorders, 26*, 643-649.

Gabig, C. S. (2008). Verbal working memory and story retelling in school-age children with autism. *Language, Speech, and Hearing Services in Schools, 39*, 498-511.

Gast, D. L. (2010). *Single subject research methodology in behavioral sciences*. New York: Routledge.

Gibson, A. N., & Schuster, J. W. (1992). The use of simultaneous prompting for teaching expressive word recognition to preschool children. *Topics in Early Childhood Special Education, 12*, 247-267.

Graham, S., Harris, K. R., MacArthur, C., & Schwartz, S. (1991). Writing and writing instruction for students with learning disabilities: *Review of a research program. Learning Disability Quarterly, 14*, 89-114.

Higgins, K., & Boone, R. (1996). Creating individualized computer-assisted instruction for students with autism using multi-media authoring software. *Focus on Autism and Other Developmental Disabilities, 11*, 69-79.

Hunt, K. W. (1965). *Grammatical structures written at three grade levels*. (Research Report No. 3). Champaign, IL: National Council of Teachers of English.

Kaufman, A. S., & Kaufman, N. L. (1983). *Kaufman Assessment Battery for Children*. Bloomington. MN: Pearson Assessments.

Kinney, E. M., Vedora, J., & Stromer, R. (2003). Computer-presented video models to teach generative spelling to a child with an autism spectrum disorder. *Journal of Positive Behavior Interventions, 5,* 22-29.

Kurt, O., & Tekin-Iftar, E. (2008). A comparison of constant time delay and simultaneous prompting within embedded instruction on teaching leisure skills to children with autism. *Topics in Early Childhood Special Education, 28*(1), 53-64.

Lavigna, G. (1977). Communication training in mute autism adolescents using the written word. *Journal of Autism and Childhood Schizophrenia, 7*, 135-149.

Light, J. C., Beukelman, D. R., & Reichle, J. (Eds.). (2003). *Communicative competence for individuals who use AAC: From research to effective practice*. Baltimore: Brookes.

Mercer, C. D., & Mercer, A. R. (1998). *Teaching students with learning problems*. Upper Saddle River, NJ: Prentice-Hall.

Miranda-Linne, F. M., & Melin, L. (1997). A comparison of speaking and mute individuals with autism and autism-like conditions on the autism behavior checklist. *Journal of Autism and Developmental Disorders, 27*, 245-264.

Moore, D., McGrath, P., & Thorpe, J. (2000). Computer-aided learning for people with autism: A framework for research and development. *Innovations in Education and Training International, 37*, 218-227.

Morse, T. E., & Schuster, J. W. (2004). Simultaneous prompting: A review of literature. *Education and Training in Developmental Disabilities. 39*, 153-168.

Myles, B. S., Huggins, A., Rome-Lake, M., Hagiwara, T., Barnhill, G. P., & Griswold, D. E. (2003). Written profiles of children and youth with Asperger Syndrome: From research to practice. *Education and Training in Developmental Disabilities, 38*, 362-369.

National Commission on Writing. (2004). Writing: *A ticket to work… or a ticket out: A survey of business leaders*. Retrieved from http://www.collegeboard.com/prod_downloads/writingcom/writing-ticket-to-work.pdf

Nelson, K. E., & Heimann, M. (1995). Delta Messages [Computer software]. Goteberg, Sweden: Warriors Mark.

Newborg, J., Stock, J., Wnek, L., Guidubaldi, J., Svinicki, J., Dickson, J., et al. (1984). *Battelle Developmental Inventory* (2nd ed.). Rolling Meadows, IL: Riverside.

Pennington, R. (2010). Computer-assisted instruction for teaching academic skills to students with autism spectrum disorders: A review of literature. *Focus on Autism and Other Developmental Disabilities, 25*, 239-248.

Rousseau, M. K., Krantz, P. J., Poulson, C. L., Kitson, M. E., & McClannahon, L. E. (1994). Sentence combining as a technique for increasing adjective use in writing by students with autism. *Research in Developmental Disabilities, 15*(1), 19-37.

Schairer, K. S., & Nelson, N. W. (1996). Communicative possibilities of written conversations with adolescents who have autism. *Child Language Teaching & Therapy, 12*, 164-180.

Schlosser, R. W., & Blischak, D. M. (2004). Effects of speech and print feedback on spelling by children with autism. *Journal of Speech, Language, and Hearing Research, 47*, 848-862.

Schlosser, R. W., Blischak, D. M., Belfiore, P. J., Bartley, C., & Barnett, N. (1998). Effects of synthetic speech output and orthographic feedback on spelling in a student with autism: A preliminary study. *Journal of Autism and Developmental Disorders, 28*, 309-319.

Schopler, E., Reichler, R. J., & Renner, B. R. (1988). *Childhood Autism Rating Scale* (CARS). Boston, MA: Pearson.

Schuster, J. W., Griffen, A. K., & Wolery, M. (1992). Comparison of simultaneous prompting and constant time delay procedures in teaching sight words to elementary students with moderate mental retardation. *Journal of Behavioral Education, 2*, 305-325.

Schuster, J. W., Morse, T. E., Ault, M. J., Doyle, P. M., Crawford, M. R., & Wolery, M. (1998). Constant time delay with chained tasks: A review of the literature. *Education and Treatment of Children, 21*(1), 74-107.

Stromer, R., Mackay, H. A., Howell, S. R., & McVay, A. A. (1996). Teaching computer-based spelling to individuals with developmental and hearing disabilities: Transfer of stimulus control to writing tasks. *Journal of Applied Behavior Analysis, 29*, 25-42.

Sugasawara, H., & Yamamoto, J. (2007). Computer-based teaching of word construction ad reading in two students with developmental disabilities, *Behavioral Interventions, 22*, 263-277.

Walker, G. (2008). Constant and progressive time delay procedures for teaching children with autism: A literature review. *Journal of Autism and Developmental Disorders, 38*, 261-275.

Yamamoto, J., & Miya, T. (1999). Acquisition and transfer of sentence construction in autistic students: Analysis by computer-based teaching. Research in *Developmental Disabilities, 20*, 355-377.