Comparing Teacher-Directed and Computer-Assisted Constant Time Delay for Teaching Functional Sight Words to Students with Moderate Intellectual Disability

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Abstract: The purpose of this study was to compare the effectiveness and efficiency of teacher-directed and computer-assisted constant time delay strategies for teaching three students with moderate intellectual disability to read functional sight words. Target words were those found in recipes and were taught via teacher-delivered constant time delay or through a PowerPoint presentation set up with a delay interval followed by a controlling prompt. These conditions were compared using an alternating treatments design. For the purposes of generalization, students were given the task of following recipes for snacks containing previously targeted sight words. Results indicated both strategies were effective; however, the teacher-directed strategy was slightly more efficient in terms of trials to criterion. The findings are encouraging given that students with moderate intellectual disability often depend on one-on-one instruction and may benefit from instruction with PowerPoint software.

Literacy may open doors to independence and employment not available through other modalities for individuals with intellectual disability. Often, however, individuals with moderate and severe intellectual disability are faced with disadvantages with regard to acquiring literacy skills (Snell & Brown, 2006). Often, students with moderate intellectual disability have difficulty with attention including shorter attention span, loss of attention, distractibility and difficulty in attending to relevant stimuli (Westling & Fox, 2004). Problems with memory may be present including difficulties with storage and retrieval of information stored in short and long-term memory. This results in an individual’s inability to generalize and maintain skills due to a lack of adequate opportunity to practice a new skill (Westling & Fox). These learning characteristics often lend themselves to the student having higher rates of success with functional rather than traditional literacy skills.

Functional literacy, or the ability to perform reading and communicative tasks necessary to perform daily routines in various environments (Alberto, Frederick, Hughes, McIntosh, & Cihak, 2007), may provide an individual with an intellectual disability the ability to have control over choices in his life. Teaching literacy skills that are part of a functional curriculum allows students to participate in learning skills that can be used to enhance independence in their home, school and community (Brown et al., 1979).

With increasing focus on standards-based education being set forth by the No Child Left Behind (NCLB) Act and the Individuals With Disabilities Education Improvement Act (IDEA), individualized education programs (IEP) are emphasizing goals and objectives directed towards teaching individuals with disabilities to perform chronological-age-appropriate functional skills in natural environments (Brown et al., 1980). Therefore, special education teachers require a need for instructional approaches that ensure students with disabilities demonstrate annual yearly prog-
ress in a variety of subjects including reading. By teaching functional literacy, teachers and students can meet both objectives set forth by NCLB and IDEA.

A variety of response-based prompting strategies have been shown to successfully increase sight word reading abilities with students who have moderate intellectual disability. These strategies include the system of least prompts (SLP; increasing assistance), most-to-least prompting (MLP; decreasing assistance), and antecedent prompting and fading procedures (Billingsley & Romer, 1983). One prompting procedure demonstrated to be effective in increasing sight word recognition is constant time delay (CTD). The CTD procedure was established as a means of shifting stimulus control from a prompt to the target stimulus through the insertion of a fixed amount of time between the presentation of the stimulus and the delivery of a controlling prompt that ensures the student completes the response correctly (Touchette, 1971). Numerous studies have demonstrated CTD to be an effective and efficient strategy for teaching sight words to individuals with disabilities (Gast, Ault, Wolery, Doyle & Beringer, 1988; Gast, Wolery, Morris, Doyle & Meyers, 1990).

Another strategy demonstrated to be effective for teaching sight words is computer-assisted instruction (CAI). Lee and Vail (2005) taught sight words to elementary-aged students with intellectual disability or developmental delays using a specialized software program, Word Wizard. This multimedia program delivered instruction with a 5-second time delay procedure. Instruction was successful in teaching sight words and incidental information. While this type of software offers many benefits, it is not readily available to most teachers. Another option for CAI is the use of PowerPoint software.

Coleman-Martin, Heller, Cihak, and Irvine (2005) demonstrated the effectiveness of using PowerPoint software to teach reading decoding using the Nonverbal Reading Approach with three students who had severe speech impairments and either a physical disability or autism and an intellectual disability. Instruction was conducted across three conditions: teacher only, teacher and CAI, and CAI only. Results indicated that PowerPoint software can be used as an instructional tool for teaching reading to students with disabilities. Because PowerPoint software is widely available and easy to use, it offers many advantages over specialized software programs. PowerPoint presentations can increase a student’s opportunities to practice reading skills in multiple settings, including home for students who have a computer with PowerPoint or the free PowerPoint player software (Coleman, 2009). Additionally, research in a small number of studies demonstrates that PowerPoint can be combined with CTD for sight word instruction.

Yaw et al. (2011) used PowerPoint software with a 2-second delay to teach Dolch words to a sixth-grade student with Autism. During assessment trials, the student interacted with PowerPoint presentations that were visually identical to teaching PowerPoint's but lacking auditory presentation of the words. He was instructed to read each word before the 2-second delay expired while another software program, GarageBand, recorded his responses. This intervention was effective in increasing word recognition at a rapid rate. Anecdotally, the authors noted that the student enjoyed interacting with the PowerPoint presentation. Based on this study, the authors proposed that PowerPoint is an effective and efficient method to provide increased opportunities for students to respond and receive feedback.

While Yaw et al. (2011) taught traditional reading words via the use of PowerPoint with CTD, Mechling, Gast, and Krups (2007) used PowerPoint with 3-second CTD presented on a SMART Board to teach sight word reading of grocery words to a small group of high school students with moderate intellectual disability. This strategy was effective for teaching students to read target words and match grocery item photos to the target grocery word. Since the intervention occurred in a group format, observational learning was assessed and demonstrated that students were able to learn each other’s words and to acquire incidental information about target words.

Results from these studies indicate that PowerPoint presentations with built-in constant time delay may improve word reading for students with disabilities. This is consistent with other research that indicates the effectiveness of CAI. One of the benefits of CAI is that it can provide structured independent practice in the classroom without requiring extensive
amounts of teacher supervision time. The purpose of this study was to compare the effectiveness and efficiency of two constant time delay interventions: teacher-directed instruction and computer-assisted instruction for teaching functional sight words to students with moderate intellectual disability.

Method

Participants

Three elementary-aged students with moderate intellectual disability participated in this study. All students were enrolled in a rural pre-K through fifth-grade public school in the Southeastern United States. The school consisted of 524 students, the majority of whom were Caucasian. Approximately 66.8% of the total school population received free/reduced lunch including all three of the participants in the study. Selection criteria for participation in the study included: (a) receiving 25 hours of special education services in a self-contained classroom weekly, (b) having an IEP goal that targeted functional literacy, (c) having no prior experience learning through the use of a constant time delay procedure, (d) scoring a low percentage of accuracy on a pretest of 40 functional words, and (e) receiving a recommendation from the classroom teacher.

At the time of the study, Joe was a 10-year-old male identified as having a moderate intellectual disability with a secondary disability of language impairment. Using Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV), Joe had a full-scale IQ scored of 48. He received small-group instruction due to high level of support needed for acquisition of academic skills. Joe received one hour of speech/language services each week. No adaptive behavior scores were available for this participant.

When the study began, Kyle was a 12-year-old male diagnosed with multiple disabilities including autism, seizure disorder, speech/language impairment, and intellectual disability. Using the WISC-IV, Kyle received a full-scale score of 46 with a verbal comprehension score of 59. Using the Wechsler Individual Achievement Test, Second Edition (WIAT-II) Kyle received a word reading standard score of 40. Kyle’s standard scores on the Adaptive Behavior Assessment System-Second Edition (ABAS-II) were a general adaptive composite score of 56, a conceptual score of 50, a social score of 61, and a practical score of 70. Kyle received intensive small-group instruction to meet his academic and social needs. Kyle also received one hour of occupational therapy and speech/language services each week.

Jake was 10-years-old at the time of the study. Jake is diagnosed with a primary disability of intellectual disability and a secondary disability of speech impairment. Using the WISC-IV, Jake had a full-scale IQ score of 44. When tested using the Woodcock Johnson Test of Cognitive Abilities (WJ-III), Jake’s basic reading and broad reading skills scored 37 and 31 respectively. ABAS-II scores indicated a general adaptive composite score of 70, conceptual score of 65, social score of 81, and practical score of 72. Jake also received one hour of speech/language services each week.

Setting

All phases of the study occurred in a self-contained classroom for students with moderate to severe disabilities consisting of 11 students with varying intellectual disability, an interning teacher, a teaching assistant, and a classroom teacher. The interning teacher served as the primary researcher for all intervention sessions. Teacher-directed CTD intervention occurred in a one-to-one teacher to student format at a kidney-shaped table located on one side of the classroom. Computer-assisted CTD intervention occurred at one of two classroom computers located in the corner of the classroom. Dividers were placed between computers to limit any observational learning between participants.

Materials

Materials used during teacher-directed CTD consisted of 11 functional cooking words for each condition printed at 96-point font on a 4 × 6 inch note card. Words for one condition targeted making an English muffin pizza and words for the other condition targeted making instant pudding. Each card contained a picture of the corresponding word which was faded after the student reached criterion us-
ing the preferred CTD condition. Computer-directed CTD used a Macintosh desktop computer to present a PowerPoint slideshow consisting of the same 11 words used during teacher-directed CTD for each condition. Words for both conditions were presented in lower case since those letters occur more commonly in books and other reading materials. The researcher used an audio recorder to verify student responses, record the duration of each session, and for the purposes of collecting data for interobserver reliability and procedural integrity.

**Design**

Two conditions, teacher-directed CTD and computer-assisted CTD, for teaching recognition of sight words were compared using an alternating treatments design. This design allows comparison of the effectiveness and efficiency of more than one intervention on the dependent variable (Alberto & Troutman, 2006). The experimental conditions for this study were (a) baseline, (b) intervention consisting of comparison of teacher-directed CTD and computer-assisted CTD, (c) preferred CTD condition where sight words from the least efficient instructional condition were taught using procedures from the more efficient condition, (d) faded picture prompts where picture stimuli were removed, and (e) generalization during which students were asked to read words to complete a functional task.

**Baseline.** Students were assessed on recognition of 40 functional words using flashcards. Words targeted skills for making an English pizza and instant pudding (see Table 1 for a list of target words). Each word was presented and the student was asked to read the word. If the student could not read the word correctly, the word was placed in an unknown word pile. The researcher did not provide any feedback or assistance. Students were tested on the unknown words two more times to ensure that the words were unknown to him or her. Of the unknown words, 11 words on which the student received 0% correct responses were chosen for each task (pudding or pizza) to be taught during each condition (computer-assisted or teacher-directed). To decrease the possibility of practice effects, and given that only words with 0% accuracy were selected for intervention, the three sessions of preassessment were used as baseline data.

**Intervention.** Students participated in two instructional conditions which were counterbalanced to reduce possible carryover effects. A total of 11 target words were presented for each condition. The instructional conditions taught functional word sets that could be used to complete two food preparation tasks. One task included learning words that would allow

### Table 1

<table>
<thead>
<tr>
<th>Student</th>
<th>Conditions</th>
<th>Target Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe</td>
<td>Pudding</td>
<td>Pizza</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pour - spoon whisk - sauce</td>
</tr>
<tr>
<td>Kyle</td>
<td>Pudding</td>
<td>Pizza</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bowl - tomato pudding - pepperoni</td>
</tr>
<tr>
<td>Jake</td>
<td>Pizza</td>
<td>Pudding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>refrigerate - microwave add - heat serve - spread minute - slices stir - cheese cold - half milk - bread</td>
</tr>
</tbody>
</table>

Note. CAI = computer-assisted instruction; TD = teacher-directed instruction.
the student to successfully make instant pudding, while the other targeted words allowed the student to create an English muffin pizza. During the teacher-directed condition, Kyle and Joe learned functional words for completing the pudding task while Jake learned the words for completing the pizza task. During the computer-assisted condition, Kyle and Joe learned the words for completing the pizza task whereas Jake learned the words for completing the pudding task. Table 1 lists students by conditions. Students participated in both instructional conditions until 90% or higher accuracy was achieved for three consecutive sessions in each condition. The instructional condition that resulted in the student reaching criterion in fewer sessions is referred to as the preferred CTD strategy. Data were collected using event recording and permanent product recoding procedures. All sessions were audio taped for the purposes of response verification, interobserver reliability and procedural integrity. During the teacher-directed CTD, the interning teacher recorded the number of functional sight words read correctly and number of words read incorrectly. During the computer-assisted CTD condition, student responses were audio taped and scored for correctness later. The number of functional sight words read correctly was divided by the total number of words presented to calculate the percentage of accuracy.

Teacher-directed CTD. During teacher-directed CTD, each student was presented 11 words per session on flashcards that contained the word along with a picture representing the word (e.g., “pour” contained a picture of a hand pouring from a pitcher). Each teacher-directed session began with the teacher saying, “Let’s practice reading,” followed by the teacher reminding students, “Remember if you do not know what the answer is, wait and I will tell you.” During the first teacher-directed session, a 0-sec delay was implemented in which the teacher presented the card, ensured a look response, and said “What’s the word?” The correct response was modeled immediately followed by, “What’s the word?” to solicit student practice. During subsequent sessions, the teacher began the session as described, but silently counted to 4-second between saying, “What’s the word?” and modeling the correct response. To keep the conditions similar, all student responses resulted in modeling of the correct response and time for student to practice the correct response. After every two words were presented, the teacher told the students “Remember if you do not know what the answer is, wait and I will tell you.” Verbal praise for correct responses was not provided. Instead, at the completion of each session, students received verbal recognition for their participation.

Computer-assisted CTD. During the computer-assisted CTD, the students participated in completing a teacher-developed CTD PowerPoint presentation. Figure 1 displays an example of the PowerPoint presentation. Procedures were similar to the teacher-directed condition, except audio on all slides was prerecorded using the researcher’s voice. Each PowerPoint session began with a slide saying, “Let’s practice reading,” followed by a slide that reminded students, “Remember, if you do not know what the answer is, wait and I will tell you.” During the first session, a 0-second delay was used in which the computer presented the target word along with a representative picture, presented the task request, “What’s the word?” and immediately presented the word again while modeling the correct response. This was followed by, “What’s the word?” to solicit a student response. During subsequent sessions, the computer began the session as described but a 4-sec wait occurred between the task request, “What’s the word?” and the presentation of the correct response. Multiple PowerPoint presentations were created during which word order was randomized to prevent students learning the word order. All student responses resulted in modeling of correct response with a prompt to practice the correct response. After two sight words were presented and correctly modeled, the PowerPoint told students, “Remember if you do not know what the answer is, wait and I will tell you.” Student responses were recorded using a digital voice recorder. At the completion of each session, students received verbal recognition for their participation.

Preferred CTD condition. The condition in which students reached criterion with the fewest trials was determined to be the preferred condition. Once criterion of 90% accuracy for three consecutive sessions was reached in one condition, the word list from the nonpre-
ferred condition (i.e., condition in which criterion was not met) was combined with the word list from the preferred condition and instruction continued until students reached criterion of 90% accuracy for three consecutive sessions.

### Faded Picture Prompt condition.

After reaching criterion using the preferred CTD procedure, the picture stimulus was removed from all flashcards or *PowerPoint* slides. The preferred condition minus the pictures continued to be implemented similar to procedures described above. This phase continued until the students read 90% of words correctly for three consecutive sessions.

### Generalization.

During the generalization phase, students read the words in order to prepare a snack. A task analysis (see Table 2)

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**PowerPoint Slide** | **Recorded Narration / Actions**
--- | ---

**Let’s Practice Reading!**

“Let’s practice reading!”

Slide changes automatically after one-second pause.

**Now remember, if you do not know what the answer is, wait and I will tell you.**

“Now remember, if you do not know what the answer is, wait and I will tell you.”

Slide changes automatically after a one-second pause. This slide appears after every two words.

**pour**

“What’s the word?”

A four-second pause follows the narration before automatically changing to the next slide.

**pour**

“The word is ‘pour.’ What’s the word?”

This is followed by a two-second pause for the student’s response. Then the slide automatically changes.

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**Figure 1.** Example of PowerPoint Slides used during CAI 3-Second Delay Condition.
was created consisting of steps containing the functional words taught to the student during both conditions. Both reading the word and performing the steps of the task analysis were observed and recorded. The interning-teacher recorded the number of words used correctly to make the particular snack. If the student correctly read and used the word, the teacher provided verbal praise. However, if the student did not read or use the word correctly, then the teacher prompted the student by reading the word. Prompting occurred after 5s of wait time. If student could not complete the step within the 5s, the step was recorded as incorrect and the student was prompted regarding that specific word.

**Social Validity**

At the end of the study, participants completed a Likert scale survey describing their experiences and preference for each of the CTD methods. The classroom teacher and teacher’s assistant completed a Likert scale survey describing their attitudes for each of the CTD methods along with their feelings on the efficiency and effectiveness for using each of the methods. Student responses were recorded and shared with both the teacher and teaching assistant to ensure reliability.

**Results**

During baseline, students did not read any of the target words correctly. During the teacher-directed CTD condition, the mean percentage of words ready correctly increased to 78.11% and students reached criterion with a mean of 19 sessions. During the computer-assisted CTD condition, the mean percentage of words read correctly increased to 77% and students reached criterion with a mean of 24 sessions. Although the percentage of words read correctly was similar, students acquired the targeted words quicker during the teacher-directed condition. However, individual differences did occur. Table 3 displays the participants’ mean percentages of correct responses during each condition.

**Joe.** During baseline, Joe did not read any of the target words correctly. During the teacher-directed CTD condition, the mean percentage of words read correctly increased to 82% and Joe reached criteria after five sessions. During the computer-assisted CTD condition, his mean percentage of words read correctly increased to 82% and he reached criterion after seven sessions. Although the percentage of words read correctly was the same, Joe acquired the targeted words more efficiently during the teacher-directed CTD condition. Therefore, the teacher-directed CTD procedures were re-implemented to

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**TABLE 2**

Steps for Completing Generalization Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Student</th>
<th>Condition</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instant Pudding</td>
<td>Kyle</td>
<td>CAI</td>
<td>1. pour the pudding in a bowl</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. add a cup of cold milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. use a whisk to stir</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. stir the pudding for a minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. refrigerate for 5 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. serve the pudding</td>
</tr>
<tr>
<td>English Muffin Pizza</td>
<td>Joe</td>
<td>TD</td>
<td>1. put tomato sauce on half the bread</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. spread sauce with a spoon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. put cheese on top</td>
</tr>
<tr>
<td></td>
<td>Jake</td>
<td></td>
<td>4. add 4 slices of pepperoni</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. heat in microwave</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. eat the pizza</td>
</tr>
</tbody>
</table>

Note. CAI = computer-assisted instruction; TD = teacher-directed instruction.
teach the words related to making a pizza. Joe’s mean percentage of words read correctly was 91% and he required four sessions to reach criterion. When the picture prompt was removed, Joe’s mean performance increased to 94% following three sessions. During the generalization phase, Joe read and completed 100% of the task analysis correctly to make a pizza. See Figure 2 for Joe’s results.

Kyle. During baseline, Kyle did not read any of the target words correctly. During the teacher-directed CTD condition, the mean percentage of words read correctly increased to 77.38% and Kyle reached criteria after eight sessions. During the computer-assisted CTD condition, his mean percentage of words read correctly increased to 78% and he reached criterion after seven sessions. Although the percentage of words read correctly was nearly the same, Kyle acquired the targeted words more efficiently during the computer-assisted CTD condition. Therefore, the computer-assisted CTD procedures were re-implemented to teach the words related to making a pudding. Kyle’s mean percentage of words read correctly was 90.75% and he required four sessions to reach criterion. When the picture prompt was removed, Kyle’s mean performance decreased to 79% but reached criterion in six sessions. During the generalization phase, Kyle read and completed 91% of the task analysis correctly to make instant pudding. See Figure 3 for Kyle’s results.

Jake. During baseline, Jake did not read any of the target words correctly. During the

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Mean Percentage of Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Joe</td>
</tr>
<tr>
<td>TD</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>82%</td>
</tr>
<tr>
<td># of sessions</td>
<td>5</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>82%</td>
</tr>
<tr>
<td># of sessions</td>
<td>7</td>
</tr>
<tr>
<td>Preferred TD</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>91%</td>
</tr>
<tr>
<td># of sessions</td>
<td>4</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>–</td>
</tr>
<tr>
<td># of sessions</td>
<td>–</td>
</tr>
<tr>
<td>Faded Picture Prompt</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>94%</td>
</tr>
<tr>
<td># of sessions</td>
<td>3</td>
</tr>
<tr>
<td>Generalization</td>
<td></td>
</tr>
<tr>
<td>% correct</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note. CAI = computer-assisted instruction; TD = teacher-directed instruction.

Reading Functional Sight Words

Figure 2. Joe’s percentages correct of targeted vocabulary with computer-assisted instruction (CAI) and teacher-directed (TD) conditions.
teacher-directed CTD condition, the mean percentage of words read correctly increased to 75.83% and Jake reached criteria after six sessions. During the computer-assisted CTD condition, his mean percentage of words read correctly increased to 72.8% and he reached criterion after seven sessions. Although the percentage of words read correctly was similar, Jake attained the targeted words more efficiently during the teacher-directed CTD condition. Therefore, the teacher-directed CTD procedures were re-implemented to teach the words related to making a pizza. Jake’s mean percentage of words read correctly was 88.75% and he required four sessions to reach criterion. When the picture prompt was removed, Jake’s mean performance increased to 94% following three sessions. During the generalization phase, Jake read and completed 100% of the task analysis to make a pizza. See Figure 4 for Jake’s results.

Social Validity

Students completed a one-on-one survey with the researcher to measure the social validity and student approval of the CTD conditions. All students agreed that they enjoyed using the computer to practice reading, thought the computer helped them improve their reading, and enjoyed making the snack. Students all expressed interest in using the computer again for reading instruction. Two out of the three students agreed that they enjoyed working individually with the teacher during teacher-directed CTD sessions. Kyle was the only participant that was unsure how he felt toward the teacher-directed CTD condition. He also was the only student who reached criterion more efficiently during the computer-assisted CTD condition. All participants expressed enjoyment in their participation of making the snack at the completion of the study.

A teacher survey was designed to assess the classroom teacher and teaching assistant’s approval and social validity of the strategies used. Both teachers strongly agreed with each of the questions on the survey. The classroom teacher additionally responded that she noticed the participants’ increase in completion of other classroom responsibilities in order to participate in their sessions for the study.

Interobserver Reliability and Procedural Integrity

All sessions were recorded using a digital audio recorder for the purposes of interobserver reliability and procedural fidelity. Interobserver reliability and procedural fidelity data were collected on a minimum on 33% of sessions for each student. To determine the percentage of interobserver reliability, the num-
ber of agreements was divided by the number of agreements plus disagreements. Procedural integrity was determined by rating the researcher’s adherence via a checklist of intervention procedures. Means for interobserver reliability and procedural integrity were 100%.

Discussion

The purpose of this study was to compare the effectiveness and efficiency of teaching functional sight words to students with moderate intellectual disability using teacher-directed and computer-assisted constant time delay. Results indicated both conditions were effective in teaching sight word reading to all three students. However, the results showed two of the three students learned words more efficiently during the teacher-directed CTD condition in terms of trials to criterion.

Of the three participants, the student with autism, Kyle, was the only student to reach criteria more quickly during the computer-assisted CTD condition. This difference could be due to Kyle’s difficulty in maintaining higher teacher demands during the teacher-directed CTD condition compared to the computer-assisted CTD condition. This is consistent with Coleman-Martin, et al. (2005) which demonstrated preference for learning via PowerPoint for a student with autism. Further research may be necessary to confirm this finding. Alternatively, Joe and Jake both displayed a preference for the teacher-directed CTD condition. Joe’s data indicated that both conditions were equally effective for teaching sight words. He achieved 91% during the third session for each condition. However, in the teacher-directed condition, he continued at 91% for two more sessions, thus reaching criterion, while he fell back to 82% accuracy for one session. Therefore, teacher-directed CTD was only slightly more efficient for Joe. In terms of effectiveness, Joe reached 100% accuracy on his last session of computer-assisted CTD whereas he did not reach 100% during teacher-directed instruction. Jake’s data displayed a clear fractionation between the two conditions after the third session. His data indicate that computer-assisted instruction may not be the best strategy for him. This could be due to many factors including increased adult attention or difficulty attending to computerized stimuli. Jake seemed to have difficulty focusing on the computer presentations rather than other classroom activities, whereas he was more attentive during teacher-directed instruction. Nonetheless, he was able to reach criterion with computer-assisted instruction.

In terms of time efficiency, teacher-directed CTD sessions were shorter in average duration.

Figure 4. Jake’s percentages correct of targeted vocabulary with computer-assisted (CAI) and teacher directed (TD) conditions.
(average of 1.9 minutes during teacher-directed CTD condition and 2.5 minutes during computer-assisted CTD condition). This is due to the structured pace of the PowerPoint presentations compared to the researcher being able to eliminate pauses upon correct student responding or pauses between the end of one trial (word) and the next trial in the teacher-directed condition. Additionally, the PowerPoint presentations took more time to prepare than the flashcards. However, once slides for a word were created in PowerPoint, it was easy for the researcher to copy and paste them into new presentations. For teachers, once a PowerPoint presentation is created, it can be used for multiple students from year to year for the time investment to have a larger payoff. The bigger time factor was direct teacher instructional time. During computer-assisted CTD, the teacher did not have to instruct each student individually. The PowerPoint presentations were used to instruct multiple students in a one-on-one format without direct teacher one-on-one instruction. Thus, average teacher time during computer-assisted CTD instruction was 0 minutes as compared to 1.9 minutes multiplied by 3 students for an average of 5.7 minutes each day for teacher-directed CTD.

**Limitations**

There are several limitations of this study. The first limitation is the lack of ability to generalize findings given the small number of participants and absence of female participants. A second limitation stemmed from difficulties associated with technology. Sessions occurred while other students were engaged in other activities. Jake was easily distracted by activities occurring in the classroom while working on the computer. The time required to make the PowerPoint presentations was also a factor. Slides were created by an interning teacher. He reported that slides initially were time-consuming but required less time to complete after his proficiency with PowerPoint software increased. A final limitation was student absences during the study, which could have possibly affected word acquisition. During the study, Jake received two days of out of school suspension between the collection of baseline data and the implementation of the intervention procedures. Joe also was absent quite frequently throughout the intervention procedures. Kyle’s participation and motivation were affected due to his behavior during other classroom activities.

**Future Research**

Further research is needed to verify the results of this study and to examine a larger number of participants, especially females and students with a variety of ability levels. Future research should focus on words that can be applied in a larger variety of activities to increase the utility of computer-assisted CTD in a variety of contexts. Future studies could include the use of computer-assisted CTD to teach chained tasks or to learn other functional academic skills such as money recognition, community survival words, etc. In addition, further studies should be conducted comparing the effectiveness of teacher-directed CTD and computer-assisted CTD to delineate which condition is most appropriate for students with autism.

**Conclusion**

This study extended current research by using individually-presented PowerPoint’s with embedded constant time delay for the instruction of recipe words for students with moderate intellectual disability. Previous research has demonstrated computer-assisted CTD to be an effective strategy for teaching multiplication facts (Wilson, Majsterek, & Simmons, 1996), Dolch words (Yaw et al., 2011) or grocery words presented on a SMART Board to a small group of students (Mechling et al., 2007). Additionally, this study is unique in that it compared computer-assisted and teacher-assisted constant time delay. Finally, this study extends the literature by demonstrating generalization of recipe words taught through a combination of constant time delay strategies to the task of food preparation.

This study presents many possibilities for effective teaching strategies in a classroom setting. Although the teacher-directed CTD condition was more efficient, results indicated that both teacher-directed CTD and computer-assisted CTD strategies can be used to teach sight words effectively. This supports Cole-
man-Martin et al. (2005) by demonstrating that, for most students, initial teaching should begin with teacher-directed instruction with computer-assisted instruction used for further practice and reinforcement of skill development. When used in conjunction with other forms of instruction, technology, specifically PowerPoint software, can strengthen a student’s ability to learn sight words. CTD is an effective and efficient method for teaching sight words due to the reduced amount of student guessing (Wolery, Ault, & Doyle, 1992). Because computer-assisted instruction allows the student to work independently, presentation of CTD using PowerPoint can allow instruction to occur while freeing the teacher to work with other students. This is especially beneficial considering that finding meaningful learning tasks which can be completed individually by students with moderate intellectual disability often poses a challenge to teachers. Furthermore, students who have computers at home could be afforded the opportunity to practice skills at home if PowerPoint presentations are sent home on a CD-ROM or flash drive.

The effectiveness of computer-assisted CTD, student engagement during CAI sessions, and specified interest during assessment of social validity suggest that technology can be used effectively with students who have moderate intellectual disability. As technology becomes more sophisticated, greater possibilities of enhancing student learning will become possible. In addition, as people use technology in everyday life, students with moderate intellectual disability need to be able to do the same. Using PowerPoint software, a form of technology not generally considered for meeting the needs of students with moderate intellectual disability, may provide these students with unique learning opportunities that may enhance skill development and, thus, increase quality of life.

References


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