☑ CE Article

Using Constant Time Delay to Teach Braille and the Nemeth Code for Mathematics and Science Notation to Students Making the Transition from Print to Braille

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Structured abstract: *Introduction:* Many students with adventitious vision loss or progressive vision loss need to transition from print to braille as a primary literacy medium. It is important that this transition is handled efficiently so that the student can have continued access to a literacy medium and make progress in the core curriculum. For this study, we used constant time delay to teach literary braille contractions and Nemeth Code for Mathematics and Science Notation (hereafter, Nemeth Code) braille symbols to learners with visual impairments who were making the transition from print to braille. *Methods:* A single-subject, multiple-probe research design was used to test the effectiveness and efficiency of constant time delay to teach literary braille or Nemeth Code. Three female students, aged 13 to 15 years, participated at a specialized school for students with visual impairments. The students' braille and math instructor delivered interventions in the classroom. Procedural fidelity and interobserver agreement data were collected. *Results:* Two students each learned 40 short-form literary braille contractions, and one student learned 28 Nemeth Code symbols throughout the study. Students appeared to generalize learning after instruction with the first word set to identify similar contractions. Students maintained learning throughout the study at high levels. Visual analysis of the data suggests a functional relationship between constant time delay and contraction identification. *Discussion*: This study replicated previous work (Hooper, Ivy, & Hatton, 2014) to expand understanding of the scope of the usefulness of time delay in braille education. *Implications for practitioners:* For students making the transition from print to braille, constant time delay may be an efficient method to help students acquire braille. The efficiency itself may increase students' confidence and motivation to learn braille.

Students with visual impairments require more time to acquire skills than their typically developing peers, and often need direct instruction to learn skills that children without visual impairments learn incidentally (Ferrell, Shaw, & Deitz, 1998; Wall Emerson, Holbrook, & D'Andrea, 2009). In addition, visually impaired students are expected to learn two sets of curricula in the same amount of time in which other students are expected to learn one. Not only do visually impaired students need to meet the Common Core or other state standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), but they also need to be provided with explicit instruction to master skills from the expanded core curriculum (ECC; Hatlen, 1996). For example, not only do students who are blind need to learn essential skills for reading, but they must also learn the braille code. Print readers who experience vision loss to the degree to which print is no longer accessible or efficient for reading need to learn braille in the most efficient manner possible to enable access to written materials with minimal disruption in content acquisition. Therefore, it is extremely important that classroom time is used wisely by implementing not only effective but efficient strategies.

Time delay is a systematic response-prompting procedure that has a strong evidence base that supports its use in teaching a variety of skills to students with disabilities. As defined by Cooper, Heron, and Heward (2007), time delay is characterized by two phases: an *instructional phase,* in which a stimulus (such as a print word) and a prompt (such as an interventionist reading the word aloud) are delivered to a student in immediate succession (0-second delay); and a *fading phase,* in which a time delay (such as 5 seconds) is inserted between the presentation of the stimulus and the prompt, providing the opportunity for a student to respond independently. Time delay has been identified as an evidence-based practice to teach discrete skills to students with disabilities in small-group instruction (Ledford, Lane, Elam, & Wolery, 2012), to teach students with autism (National Professional Development Center on Autism Spectrum Disorder, 2010), and to teach a range of academic skills to students with severe developmental disabilities (Spooner, Knight, Browder, & Smith, 2012), including specifically picture and sight-word recognition (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009). In addition to being effective, time delay has shown to be more efficient than other types of response prompting procedures in general (Demchak, 1990; Handen & Zane, 1987; Schuster et al., 1998; Wolery et al., 1992), and to teach sight-word recognition specifically (Walker, 2008). Ivy and Hatton (2014) reviewed research studies that isolated the effects of response prompting on skill acquisition for persons with little to no functional vision and found that time delay has been explored very little with this group of learners.

Hooper, Ivy, and Hatton (2014) demonstrated the efficacy of a 5-second constant time delay to teach braille word recognition to four students, aged 10 to 11 years, with visual impairments and additional disabilities who were performing at least one grade below their reading level. Three participants were able to identify most letters of the alphabet and at least some corresponding whole-word contractions in English

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Table 1
Participant characteristics.

Participant	Age	Diagnoses	Visual acuity	Primary literacy medium	Braille assessment results
Beth	13.4	Aphakia, glaucoma	20/200	Print	25.7%
Erin	15.8	Aniridia, glaucoma	CF at 1 inch	Braille	34.7%
Amanda	14.9	Bilateral optic atrophy	NLP	Braille	91.0%

Age is reported in years and months. CF = counting fingers; NLP = no light perception. Braille assessment results are reported as the percentage of known symbols in the following skill areas from *Braille: Contracted Reading and Writing* in *EVALS* (N = 222): alphabet letters (n = 26), alphabet words (l = 24), part words (l = 7), whole or part words (l = 22), lower cells (l = 20), initial letter dot 5 (l = 22), initial letter dot 4-5 (l = 5), initial letter dot 4-5-6 (l = 6), final letter dot 4-6 (n = 5), final letter dot 5-6 (n = 7), final letter dot 6 (n = 2), and short-form words (n = 76).

Braille American Edition (EBAE); however, they were not yet demonstrating reliable decoding skills. One student was not yet facile with the braille alphabet, but could inconsistently recognize his name in EBAE. Words selected for time delay instruction were collected through interviews with students, teachers, and caregivers to "spark excitement, engagement, and emotion in students" (Wormsley, 2011, p. 147). The four students each mastered automatic recognition of 9 to 12 "highly motivating" words in 13 to 36 instructional sessions. A functional relationship was demonstrated with each participant. The results demonstrated the efficacy and efficiency of constant time delay in teaching braille word recognition; however, students had difficulty maintaining some word learning for the length of the study.

The current study is a systematic replication of Hooper et al. (2014) to teach short-form contractions in EBAE or Nemeth Code for Mathematics and Science Notation (hereafter, Nemeth Code) symbols to students making the transition from print to braille. To our knowledge, it is the first study to teach isolated braille and Nemeth Code symbols using time delay. The purpose of the study was threefold: to test the effectiveness of constant time delay in teaching middle school students to accurately and consistently identify braille contractions and Nemeth Code symbols, to test the efficiency of constant time delay in teaching students to accurately and consistently identify contractions, and to test the extent to which students maintained learning.

Methods

The institutional review board at Vanderbilt University approved all procedures. Written consent was obtained from the participants and their guardians prior to the start of the study.

Participants

Three adolescent females who attended a specialized school for students with visual impairments were selected for the study. Each participant was diagnosed with an adventitious or a degenerative visual condition with no additional disabilities. Although the first literacy medium for all participants was print, based on their current visual functioning, all three students were in the process of making a full transition to use braille as their primary literacy medium. Details regarding participants are presented in Table 1.

Erin

At the start of the study, Erin's functional vision no longer allowed her to access print. All academic instruction throughout the school day occurred verbally or in braille. However, Erin had not yet been taught all of the literary braille code.

Beth

Throughout the study, Beth's functional vision still allowed her to access print; however, her educational team decided that print was an inefficient mode for accessing written materials for academic instruction. Although her instructional materials were being presented in a visual format, she was receiving braille instruction to transition to a more efficient literacy medium. Beth had not yet been taught all of the literary braille code.

Amanda

At the start of the study, Amanda's functional vision no longer allowed her to access print. Unlike Erin and Beth, she had mastered most of the literary braille code. Her instructional materials were presented primarily in braille; however, she had only received instruction in some of the Nemeth Code. According to her classroom teacher, limited knowledge of the Nemeth Code inhibited her ability to demonstrate a mastery of mathematics concepts on the annual standardized assessment.

Setting, materials, and word and symbol selection

Setting

Instruction occurred in the students' typical classroom during braille or mathematics lessons. The classroom teacher provided instruction in a one-to-one format at a table in the back of the classroom. An observer was present for at least 33% of sessions to collect reliability data.

Materials

Braille was created using a Perkins Brailler on 3-by-5 index cards with the top right corner removed. From left to right, each card consisted of a lead-in line (dots 2-5), one space, the word or mathematic symbol in the center of the card, one space, and a lead-out line (dots 2-5). When presented to the participants, the cards were placed on a rubber mat to minimize movement of the cards while they were being read.

Word and symbol selection

Braille words were selected for instruction using assessment results from the "Braille: Contracted Reading & Writing" chapter of *EVALS: Evaluating Visually Impaired Students* (Texas School for the Blind and Visually Impaired, 2007). Forty unknown literary braille contractions were selected for instruction for Erin and Beth. We chose short-form contractions to decrease the likelihood that the content of the experimental instructional sessions would overlap with the materials being taught in their regular literacy classes so that we could isolate the effects of constant time delay on braille recognition. Based on an informal assessment with consideration of the material that would be presented on the annual standardized mathematics assessment, 28 unknown Nemeth Code symbols were selected for Amanda. Selected braille words and Nemeth Code symbols were randomly assigned to one of four sets for

Table 2
Literary braille contractions and Nemeth Code braille symbols selected for Beth, Erin, and Amanda.

Participant	Word or symbol set 1	Word or symbol set 2	Word or symbol set 3	Word or symbol set 4
Beth	immediate, although, thyself, beneath, conceive, conceiving, beyond, behind, perceive, braille	receiving, declare, herself, oneself, o'clock, receive, altogether, deceiving, together, yourself	ourselves, because, according, before, declaring, itself, deceive, always, themselves, perceiving	below, between, myself, himself, almost, yourselves, rejoicing, rejoice, afterward, beside
Erin	receiving, word, beside, declare, rejoice, these, himself, receive, although, immediate	deceiving, altogether, afterward, deceive, conceive, before, thyself, oneself, itself, ourselves	myself, together, herself, yourselves, conceiving, according, rejoicing, beneath, behind, almost	world, yourself, o'clock, perceiving, between, below, themselves, many, blind, declaring
Amanda	cents, close brackets, is not parallel to, circle, triangle, integral, hexagon,	is not perpendicular to, square, octagon, close braces, congruence, is not less than, is perpendicular to	since, theta, is parallel to, infinity, pi, open braces, beta	pound, is not greater than, alpha, open brackets, rectangle, therefore, is not equal to

each participant. For Erin and Beth, each word set consisted of 10 literary braille contractions. For Amanda, each symbol set consisted of seven Nemeth Code braille symbols. Word or symbol sets are presented in Table 2.

Response definitions

During experimental sessions, event recording was used to quantify students' ability to identify words or symbols on a trial-by-trial basis where an opportunity to identify a word or symbol was afforded in each trial. For each trial, participants' responses were classified in one of five ways: correct anticipation and correct wait, which were considered correct responses; nonwait error and wait error, which were incorrect responses; or no response. A *correct anticipation* was defined as a correct verbal and tracking response before the controlling prompt. A *correct wait* was defined as a correct verbal and tracking response after the controlling prompt. Verbal responses were considered correct if the student read the word or symbol as it was embossed on the first attempt. Tracking responses were considered correct if the student tracked the word or symbol with at least one finger from beginning to end within 1 second of a verbal response. A *nonwait error* was defined as an incorrect verbal or tracking response before the controlling prompt. A *wait error* was defined as an incorrect verbal or tracking response after the controlling prompt. Examples of incorrect verbal responses included the student mispronouncing the embossed word or symbol, or verbalizing a different form of the word or symbol (for example, said "closed bracket" instead of "closed brackets"). A *no response* was recorded if a participant made no verbal or tracking response within 5 seconds after the controlling prompt. The metric used to determine a functional relationship using visual analysis was the percentage of correct anticipations out of the total number of trials per session.

Experimental design

The efficacy of constant time delay to teach contraction identification was tested using a multiple-probe, single-case design across behaviors (Horner & Baer, 1978). In this study, a participant's ability to read each word or symbol set constituted a new behavior. The design was replicated with three students. The multiple-probe design controls for common threats to internal validity (such as history, maturation, or testing) because the independent variable is introduced in a time-lagged sequence (Gast & Ledford, 2010). Experimental control can be demonstrated by a positive change in trend or level of independent, correct responses (correct anticipations) at the time of introducing constant time delay.

General procedures

Regardless of condition, all sessions consisted of either 35 (Amanda) or 50 (Erin and Beth) trials. No more than two sessions occurred in one day, and at least two hours elapsed between sessions that occurred on the same day.

At the beginning of each session, the interventionist shuffled the word or symbol cards and verbalized directions for the student according to the condition being implemented. To initiate each trial, a word card was placed in the correct orientation for reading on a rubber mat in front of the participant. The interventionist verbally prompted the participant to find the end of the lead-in line as necessary. Then the interventionist gave the instructional cue ("Read the word." or "What is this symbol?"). At the end of a trial, the interventionist gave positive verbal reinforcement for correct responses regardless of independence (for instance, "Excellent! That is [word]!" or, "Yes! That symbol is [symbol name]."). After every fifth trial in a session, the interventionist gave general positive verbal reinforcement such as, "Thank you for reading with me" to the student for her participation.

Probe procedures

Probe procedures were implemented for three consecutive probe sessions that preceded the intervention condition for each word or symbol set, as well as at the end of the study. During each probe session, students were given opportunities to read every word or symbol included in the four sets. In this way, baseline performance was assessed for words or symbols not yet taught, and maintenance data were collected for words or symbols already taught. The number of opportunities to read a given word or symbol varied by probe session but were the same within a given probe condition: two opportunities were given for words or symbols that would be taught in the next intervention condition, and one opportunity was given for all other words or symbols. For example, in the first probe condition for Beth and Erin, 50 trials per session consisted of two opportunities to read each word or symbol in the first set and one opportunity to read each word or symbol in the other three sets. In the final probe condition, two opportunities to read words or symbols in the last set and one opportunity to read all other words or symbols were given.

At the beginning of each probe session, the following directions were given: "Today I will show you some words or symbols. If you know the word or symbol, read it. If you do not know the word or symbol, wait, and I will show you a new one." For each trial, the interventionist gave the participant 5 seconds to respond after the instructional cue. If the student made a correct response, the interventionist gave positive verbal reinforcement; otherwise, no feedback was provided to the student.

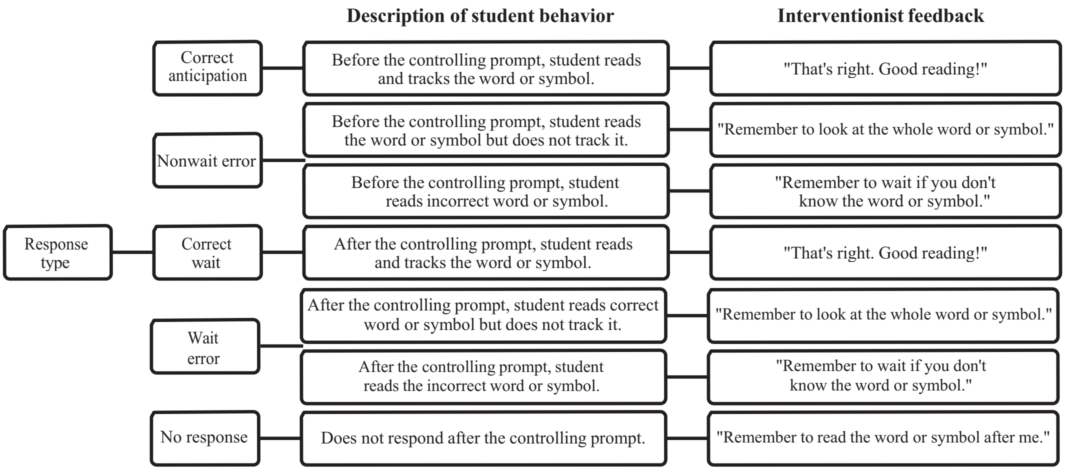

Figure 1. Description of student behavior and interventionist feedback by response type.

Intervention procedures

Intervention procedures were implemented for each word or symbol set, one at a time, following each probe condition. Intervention sessions afforded students five opportunities to read each word or symbol in a given set. Two types of sessions were implemented during intervention that corresponded to the length of delay implemented between the instructional cue and the controlling prompt (0 seconds and 5 seconds). To begin intervention for a given set, sessions were implemented with 0-second delay trials until the student reached 100% correct waits for an entire session. Thereafter, sessions were implemented with 5-second delay trials until the student reached 100% correct anticipations for an entire session. During intervention, the interventionist reading aloud the word or symbol served as the controlling prompt. At the end of each trial, the interventionist gave verbal feedback to the student according to the student's response. Descriptions of student behavior and interventionist feedback by response type are provided in Figure 1.

The following directions were given at the beginning of each 0-second delay session: "Today I will show you some words or symbols. First, I will read the word or symbol. Then you can read it after me." In 0-second delay trials, the controlling prompt immediately followed the instructional cue; therefore, the student did not have the opportunity to respond independently. After the controlling prompt, the interventionist waited 5 seconds for a response, then provided instructional feedback, and began the next trial.

The following directions were given at the beginning of each 5-second delay session: "Today I will show you some words or symbols. If you know the word or symbol, read it. If you don't know it, wait, and I will read the word or symbol to you. Then you can read the word or symbol." The interventionist implemented a 5-second delay after the instructional cue, which allowed the participant to respond independently. If the student did not respond after 5 seconds, the controlling prompt was given. After the controlling prompt, the interventionist waited 5 seconds for a response, then provided instructional feedback, and began the next trial.

Reliability

An independent observer collected data in real time to estimate the accuracy with which the interventionist followed procedures (procedural fidelity) and recorded student responses (interobserver agreement). Data were collected during at least 33% of sessions for each condition, word set, and participant. Dependent variable data were graphed to detect potential observer drift of bias (Artman, Wolery, & Yoder, 2010). In addition, point-by-point agreement was calculated using the following formula (Ayres & Gast, 2010):

> Interobserver agreement = (Number of agreements/Number of agreements and disagreements) × 100

Data were collected to estimate procedural fidelity of the following variables, which occurred once per session: correct placement of the rubber mat, consistent greeting and dismissal of the student, randomization of word or symbol order, and appropriate directions read to student. In addition, procedural fidelity was estimated by the occurrence or nonoccurrence of the following variables, which were recorded on a trial-by-trial basis: presentation of a new, correctly placed word or symbol; provision of an instructional cue; correct administration of a time delay; correct administration of a controlling prompt; no additional assistance; and noncontingent verbal praise for attentive behavior. Procedural fidelity was calculated using the following formula (Ayres & Gast, 2010):

> Procedural fidelity = (Number of occurrences/Number of occurrences and nonoccurences) × 100

Interobserver agreement was less than 100% for only six sessions; for all sessions, the average was 99.4% (range: 94.3 to 100%). In addition, minimal discrepancies between first and second observer data did not influence the effect used to determine a functional relation, as can be seen in Figures 2, 3, and 4. Procedural fidelity was 100% for all except four behaviors, for which procedural fidelity was still an average of above 99% for all sessions. These behaviors included correct administration of time delay (*M* = 99.8%, range = 97.1 to 100%), correct administration of controlling prompt (*M* = 99.9%, range = 98 to 100%), no additional assistance (*M* = 99.9%, range = 97.1 to 100%), and correct administration of noncontingent verbal praise for attentive behavior (*M* = 99.2%, range = 97.1 to 100%).

Results

Three students learned all words or symbols presented in the four sets, and they maintained learning for the length of the study. For each set of symbols, students participated in only one 0-second delay session and two to six 5-second delay sessions. First and second observer data for correct prompted and unprompted responses are presented for each participant in Figures 2 through 4. The data clearly demonstrate a functional relationship between constant time delay and word or symbol identification, evidenced by immediate changes in level when the intervention was introduced for all word or symbol

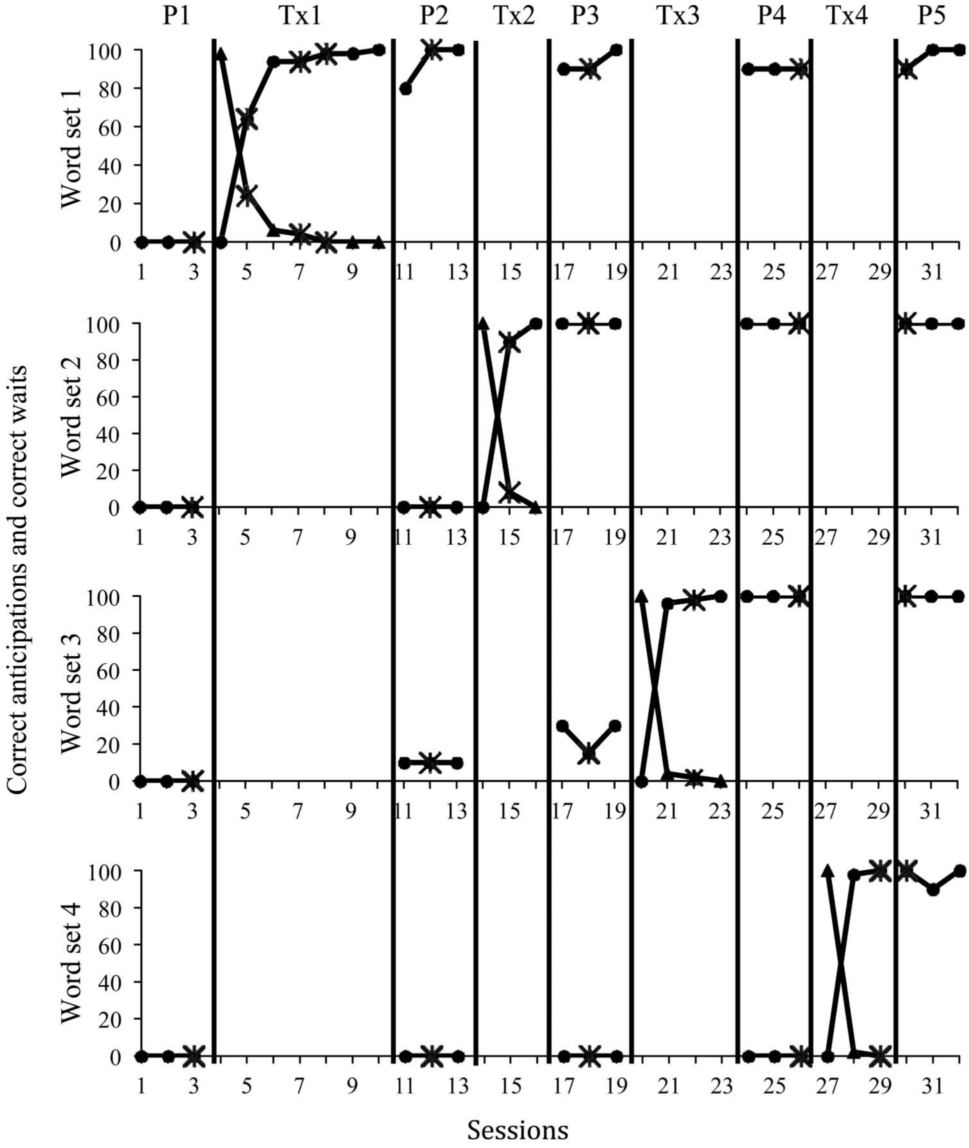

Figure 2. Percent correct anticipations (represented by circles) and correct waits (represented by triangles) for Beth. Data from an independent observer are indicated with "X."

sets with all three participants. For seven sets, no changes were observed before constant time delay. For three sets, minimal changes were observed (≤ 30% correct anticipations) before the intervention. For two sets, moderate changes (40–60% correct anticipations) were observed before. Afterwards, students maintained learning at high levels, and accuracy did not appear to decline when new contractions were introduced.

Beth

Given constant time delay, Beth learned 37 of 40 braille words in 17 instructional sessions that were held on 12 different instructional days over a period of 1 month. During the first

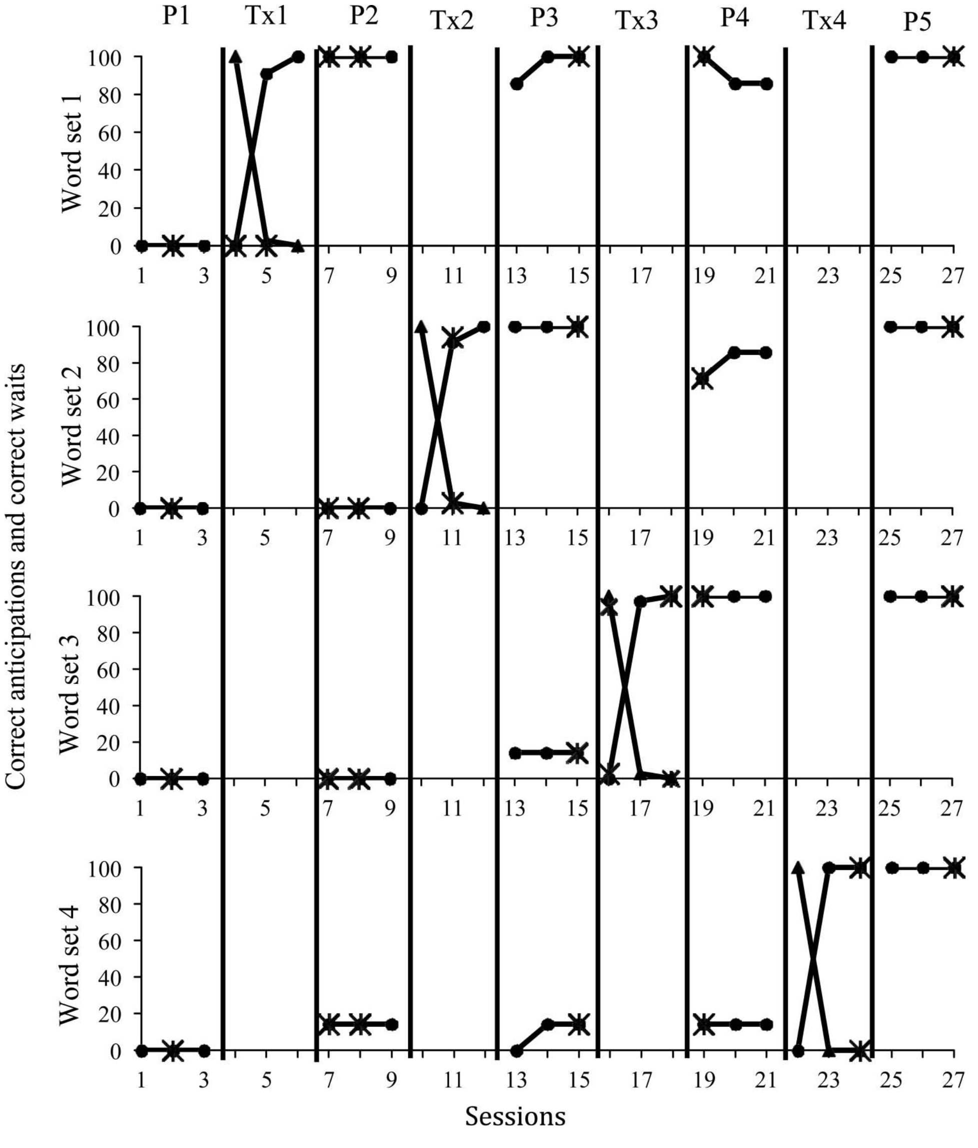

Figure 3. Percent correct anticipations (represented by circles) and correct waits (represented by triangles) for Amanda. Data from an independent observer are indicated with "X."

probe condition, Beth was not able to identify any of the words, as shown in Figure 2. She identified 3 words in the third set prior to constant time delay instruction. With instruction using constant time delay, she identified 100% of the words in each set within 3 to 7 sessions. After instruction, she maintained accuracy above 80% for the length of the study. In her last probe session, she identified all 40 words with 100% accuracy.

After instruction on the first word set, it appeared that Beth began to generalize identification of parts of words to figure out words not yet taught. She demonstrated several examples of this generalization. For instance, after learning *conceive*,

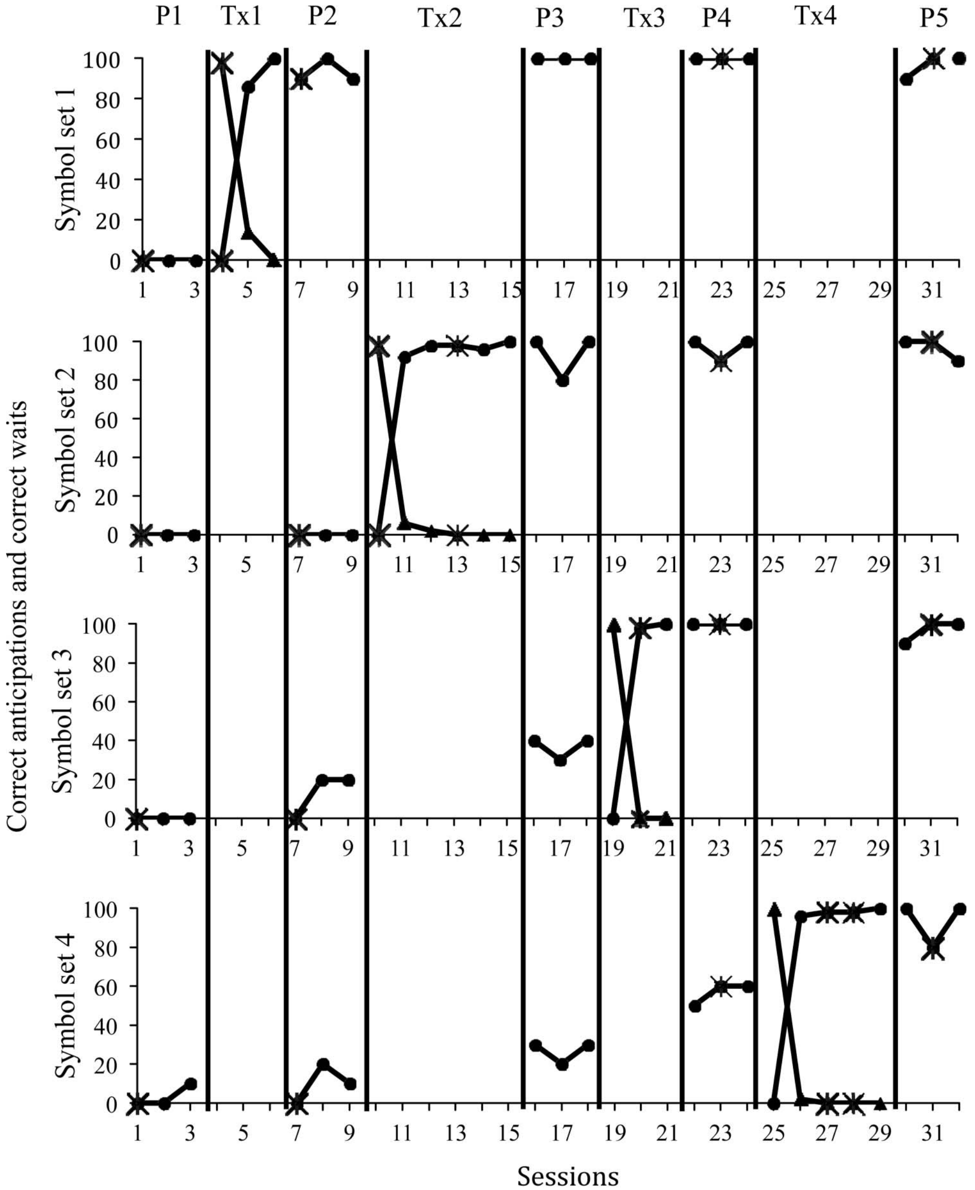

Figure 4. Percent correct anticipations (represented by circles) and correct waits (represented by triangles) for Erin. Data from an independent observer are indicated with "X."

conceiving, and *perceive* in the first word set, Beth identified *perceiving* in the next probe condition without having received direct instruction with that contraction. However, during the same probe condition, she was not able to identify *receive*, *deceive*, *receiving*, or *deceiving*. After learning *declare* and *deceiving* in the second word set, Beth identified *declaring* and *deceive* in the third probe condition. However, she did not identify *rejoice* or *rejoicing* until they were taught directly in the final word set. Also, although Beth did not know the contraction *th* before the study, shortly after learning to recognize *although* for this study Beth's teacher reported the following scenario that occurred during free time in her writing class: Beth was teaching braille to a sighted classmate who wanted to write a word with *th* in it, and asked her teacher if dots 1-4-5-6 represented *th* like in *although.*

Amanda

Given constant time delay instruction, Amanda learned 26 of 28 Nemeth Code symbols in 12 instructional sessions that were held on 8 different instructional days over a period of approximately 1 month. During the first probe condition, Amanda was not able to identify any of the symbols, as shown in Figure 3. She identified 1 symbol in the third set and 1 symbol in the fourth set prior to the intervention. With constant time delay instruction, she identified 100% of the symbols in each set within 3 sessions. For the last symbol set, she identified all symbols during her second session, but we decided to collect a minimum of 3 data points per condition. After instruction, she maintained accuracy above 80% for the length of the study except in 1 session (session 19). In her last 3 probe sessions, she identified all 28 symbols with 100% accuracy.

Over the course of the study, Amanda was able to identify two Nemeth Code symbols without direct instruction. After learning *closed brackets* in the first symbol set, Amanda identified *open brackets* without instruction. Similarly, after learning *closed braces* in the second symbol set, she identified *open braces* without instruction. The interventionist did not ask Amanda how she was able to identify *open brackets* without instruction. Although there is a logical relationship between symbols she identified to those previously learned, it could be that she made a logical guess or that she encountered the symbol outside of the experimental session.

Erin

Given constant time delay instruction, Erin learned 30 of 40 braille words in 17 instructional sessions held on 12 different instructional days over a period of 1 month. During the first probe condition, Erin identified *blind* in the third session, as shown in Figure 4. Erin identified an increasing number of words without direct instruction. In the third set she identified 4 words without constant time delay. In the fourth set she identified 6 words without constant time delay. With constant time delay instruction, she identified 100% of words in each set within 3 to 6 sessions. After instruction, she maintained accuracy above 80% for the length of the study.

Two words Erin identified without instruction, *blind* and *below*, did not bear resemblance to previously taught words. Over 9 probe sessions, Erin identified an additional 8 words without direct instruction. After learning *himself* in the first word set, Erin identified *myself, herself, and yourself,* but did not recognize *oneself, thyself, or itself*. After learning *ourselves* and *yourselves* in the second and third word sets, respectively, Erin identified *themselves* without instruction. After learning *receive, receiving, declare, and rejoice* in the first word set, Erin was not able to identify similar words such as *deceive* or *rejoicing.* However, after learning *deceive, deceiving,* and *conceive* in the second word set, Erin did recognize *conceiving, rejoicing*, and *declaring* without instruction. Interestingly, Erin did not mistake *world* for *word* after learning *word* in the second set, even though there is only a 1-dot difference.

Discussion

This study was planned to replicate and expand earlier work that showed that constant time delay was effective and efficient to teach automatic word recognition to young braille learners with additional disabilities (Hooper et al., 2014). It was our thinking that constant time delay could be very useful to teach unknown contractions to older students who were making the transition from print to braille who needed to learn the code quickly in order to facilitate access to written materials in other subject areas. Hence, students in this study were eligible for services under the primary classification of visual impairment, unlike students in Hooper et al. (2014), who qualified for services under the classification of multiple disabilities. In addition, we changed the procedures used in the previous study in three major ways, by increasing the size of each word or symbol set from three highly motivating words to 7 to 10 braille or Nemeth Code contractions; by changing mastery criterion from 83.3% over 3 sessions to 100% accuracy for a single session; and by changing the controlling prompt from a physical and verbal prompt, which included pointing out 2 salient tactile features of a word, to a verbal prompt, which only consisted of stating the correct word or symbol.

Effectiveness of constant time delay

Three adolescent students making the transition from print to braille at the time of the study learned between 28 and 40 words or symbols in approximately a 1-month period. Of the 108 words or symbols slated for instruction among the three students, 15 were acquired prior to introduction of constant time delay. Most of the words or symbols identified in probe sessions prior to instruction were alternate forms of words or symbols previously taught (for example, *declaring* and *declare*, *open* and *closed braces*). Students quickly learned the other 93 words or symbols with constant time delay instruction. A functional relationship between constant time delay and the correct identification of words or symbols was established by immediate changes in the percentage of correct unprompted trials from probe to intervention across 4 word or symbol sets, replicated with 3 participants. The results corroborate findings of Hooper et al. (2014), and suggest that constant time delay is an effective method to teach literary braille contractions and Nemeth Code symbols to adolescent students making the transition from print to braille.

Efficiency of constant time delay and maintenance of learning

All 3 participants completed the study in approximately 1 month. Students who were taught literary braille learned all 40 contractions within only 12 instructional sessions. The student who was taught Nemeth Code learned 28 symbols within only 8 instructional sessions. Instructional sessions lasted approximately 15 minutes, and no more than 2 were held in the same day. In addition to constant time delay being a very efficient method for instruction, students maintained near-perfect levels of accuracy with previously taught contractions as new contractions were introduced, increasing the cognitive demand of the task. Maintenance of learning was much greater for this group of students than students with visual impairments and additional disabilities who participated in the Hooper et al. (2014) study. It is unclear whether this improved performance is related to procedural variables such as the higher mastery criterion used for this study or student characteristics such as age or the absence of additional disabilities.

Implications for practice and future research

D'Andrea (1997) explains the importance of motivation as a factor influencing a student's transition from print to braille. She suggests using motivating content to create the opportunity for a student to immediately succeed with the transition. However, academic students may be as motivated by success in learning the braille code quickly as they are by interesting content. For the students in this study, learning the code quickly seemed to be sufficient motivation to participate, succeed, and maintain learning. Unfortunately, we are not able to report students' prior experience with braille or literacy instruction. Future research should explore the appropriateness of using constant time delay to introduce braille with or without additional tactile readiness and perceptual training. The students in this study already knew at least one quarter of the braille code. How students with little or no braille skills would respond remains to be studied.

Finally, empirical data and anecdotal evidence suggest that students may have generalized learning from constant time delay instructional sessions to probe sessions and typical classroom environments. The data on student generalization may be supported by theories related to recombinative generalization, "defined as the demonstration of novel arrangements of previously established linguistic units" (Suchowierska, 2006, p. 514). For example, this may explain why one student identified *declaring* after being taught *declare* and *deceiving*. One instructional approach to support recombinative generalization is matrix training, which in this case would involve introducing braille contractions in a specific order to support generalization. Future research should incorporate more meaningful generalization measures (such as identification of words in connected texts) and should explore matrix training for teaching braille.

Conclusion

The results of this study support the use of constant time delay to teach word or symbol identification to those students making the transition from print to braille who could benefit from an efficient instructional method. Constant time delay is intended to complement, not replace, current instructional approaches to teaching dual-media learners, which include practice reading and writing connected text. More research is needed to explore factors that affect learning and generalization.

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