*A COMPUTER-BASED PROGRAM TO TEACH BRAILLE READING TO
SIGHTED INDIVIDUALS*

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Instructors of the visually impaired need efficient braille-training methods. This study conducted a preliminary evaluation of a computer-based program intended to teach the relation between braille characters and English letters using a matching-to-sample format with 4 sighted college students. Each participant mastered matching visual depictions of the braille alphabet to their printed-word counterparts. Further, each participant increased the number of words they read in a braille passage following this training. These gains were maintained at variable levels on a maintenance probe conducted 2 to 4 weeks after training.

Key words: braille, computer-based instruction, matching to sample, reading, teacher training, undergraduates, verbal behavior

As of 2011, approximately 1.4 million children under the age of 15 years worldwide met the International Classification of Diseases (ICD-10) criteria for irreversible blindness (World Health Organization, 2011) with vision worse than 20/400 acuity or less than 10 degrees of the visual field in the best eye with the best corrective device possible. Even greater numbers met the criteria for legal blindness (visual acuity 20/200 or less with less than 20 degrees of the visual field) or low vision (visual acuity between 20/70 and 20/200). Among the many learning challenges faced by students with visual impairments, the development of literacy is particularly problematic. Recent research suggests the literacy rates for visually impaired students have decreased considerably in recent years, while the visually impaired population has grown (Braille Institute, 2010). Estimates

by the National Braille Press suggest that only 12% of legally blind individuals can read braille, which is a substantial decline from the 50% of reported braille readers in the 1960s (Brittain, 2007). The braille code is one means of developing literacy for blind individuals in which each letter and number of the English alphabet is represented by a unique tactile symbol. Each symbol is composed of the presence or absence of a raised dot in up to six locations in a cell comprised of two columns and three rows. Each dot is approximately 1 mm in diameter, and there is approximately 1.5 mm between the midpoints of each dot location within a standard cell. Each word of the English language can be transcribed into braille with a point-to-point correspondence between the text letter and the braille symbol.¹

Along with the decline in literacy rates, classroom-based braille instruction has decreased over the past several decades. In 1968,

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¹This statement is true of alphabetic (Level 1) braille. Contracted (Level 2) braille includes a number of contractions of commonly occurring words that are not part of typical English writing. With some debate among the braille community, those contractions typically are introduced following mastery of alphabetic braille.

40% of students with visual impairment enrolled in elementary and secondary education were reported to be reading braille, but in more recent years these estimated levels dropped to between 9% and 22% (Braille Institute, 2010; Department of Field Services of the American Printing House for the Blind, 2009; National Federation of the Blind, 2009). Some have suggested that individuals with visual impairment may be less reliant on braille due to the increased availability of large-print books and advances in technology that make auditory media more available and accessible (Johnson, 1996). Although technology may replace the need for braille literacy under some circumstances, the complete omission of braille literacy may limit individuals' opportunities for independence throughout life (e.g., braille is often available in public places such as elevators and ATMs, and much of the current technology is not transportable). Ryles (1996) reported that adults who were congenitally legally blind and were taught braille as their first means of literacy had higher employment rates, higher educational levels, and better financial stability, on average, than adults with similar disabilities but who were first taught as large-print readers.

In addition to technological advances, several sources have suggested that declining braille instruction is attributable, in part, to a deficit in qualified braille instructors (Bell, 2010; Johnson, 1996; Mason, Davidson, & McNerney, 2000; National Federation of the Blind, 2009; Ponchillia & Durant, 1995), the use of general education teachers with no braille training as braille instructors (Johnson, 1996), a lack of training programs, and different standards of qualification in those programs that do exist (Amato, 2009). Standards for training instructors of the visually impaired differ considerably among states. The Council of Exceptional Children provides an example of a rigorous training model in their certification program for teachers of the visually impaired, which requires course work in the foundations and history of the

visual system and education of the blind, developmental issues concerning visually impaired learners, individual learning differences as a result of being blind, instructional techniques for teaching braille, modifications of learning environments, alternative nonverbal communication strategies, instructional planning, assessment, and ethics (Frieman, 2006). However, most states do not use these criteria, and the qualification standards vary drastically among states. Six states currently require passing of an examination with no associated experience or course work. Other states require as many as 11 courses and completion of supervised practicum before individuals are eligible to take a qualification exam (Pogrud & Wibbenmeyer, 2008). The differences in certification requirements suggest a lack of agreement regarding the skills and experience necessary for instructors of the visually impaired, who generally are responsible for braille instruction (Bell, 2010; Frieman, 2006; Johnson, 1996; National Blindness Professional Certification Board, 2009; Rosenblum, Lewis, & D'Andrea, 2010). There is a general consensus that an instructor needs to be able to read braille, both for rapid prompting and correcting during instruction and to create instructional material (Bell, 2010; Pierce, 2006).

The reading repertoire required of a braille instructor is slightly different from that of a typical braille reader. That is, assuming that the instructor is sighted, he or she does not necessarily need to read braille tactually but rather should be able to read a braille passage visually; with this ability, the instructor can provide prompting and corrective feedback to a student. Most instructors-in-training also will differ from their students in that the instructors already possess a visual reading repertoire, whereas the majority of students learning braille are not able to read visually. Braille instruction with visually intact adults may capitalize on prior reading repertoires by attempting to establish equivalence relations between printed words and braille symbols.

An equivalence relation, based on the stimulus equivalence paradigm, is a behavioral pattern in which an individual first learns the relation of sameness (or equivalence) between at least three classes of stimuli. After this relation is trained, the individual will demonstrate the untrained emergence of additional sameness relations in the absence of further training (Rehfeldt, 2011; Sidman & Tailby, 1982). For instance, suppose an individual is taught to select Stimulus B when presented with Stimulus A (AB relation) and to select Stimulus C when presented with Stimulus B (BC relation). Stimulus equivalence would be demonstrated by the emergence of (a) reflexive relations (i.e., the individual selects each stimulus when provided with itself as a comparison; the AA, BB, and CC relations), (b) symmetric relations (i.e., the individual accurately selects the reverse of the trained relations; the BA and the CB relations), and (c) transitive relations (i.e., the individual accurately responds given the stimuli that had never been paired directly during training; the AC and CA relations; Green & Saunders, 1998). Instruction informed by stimulus equivalence research gives an instructor greater teaching efficiency in that, by targeting particular relations, relations between important classes of stimuli also may emerge without direct instruction. These forms of equivalence-based instruction have been implemented successfully, and their emergent relations successfully observed, across a wide variety of populations, including individuals with learning deficits, acquired brain injury, cognitive impairments, and intellectual disabilities, and have targeted such skills as mathematics, geography, and emotional recognition (Guercio, Podolska-Schroeder, & Rehfeldt, 2004; Hall, DeBernardis, & Reiss, 2006; LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003; Lynch & Cuvo, 1995; Rehfeldt, 2011).

Toussaint and Tiger (2010) demonstrated the utility of low-tech equivalence-based instruction to teach relations between printed letters and

their braille counterparts with four children with degenerative visual impairments who already had learned to read printed words. The training involved a matching-to-sample procedure in which the experimenters presented a braille letter as a sample stimulus (A) and taught students to select a printed-letter comparison (B) from an array of letters (i.e., the AB relation); these children had the prerequisite ability to match text letters (B) to their spoken names (C) (BC and CB relations). After mastering the AB relation, the participants then were able (a) to select the braille character when provided with the printed letter (BA relation; i.e., demonstrating symmetry), (b) to select the appropriate braille character when given the spoken name (CA relation, i.e., demonstrating transitivity), and (c) to speak the correct name when given the braille character (AC relation; i.e., demonstrating transitivity). Although these relations are important prerequisites to reading using the braille code, reading obviously requires more advanced skills than letter naming and matching. Although reading ability was not assessed in this study, it is reasonable to suggest that if individuals possess the prerequisite ability to read printed words, and if they are trained to relate printed letters to braille characters, then the corresponding ability to read braille may emerge as an additional transitive relation. That is, it may be the case that establishing equivalencies between braille characters and printed letters would be sufficient to generate rudimentary braille-reading repertoires for those with a strong print-reading repertoire.

We designed the current study as a preliminary evaluation of a braille letter-identification training program for sighted individuals using instructional procedures similar to those of Toussaint and Tiger (2010). We recruited four college students to participate, and we taught them the relations between braille characters and English letters in a computer-based matching-to-sample format. We also assessed the untrained emergence of braille reading following this training program.

METHOD

Participants

We recruited four undergraduate students enrolled at Louisiana State University as participants. Maureen was an 18-year-old Caucasian woman, Rick was a 21-year-old Caucasian man, Sarah was a 21-year-old African American woman, and Amy was a 19-year-old African American woman. We did not ask whether the students had any prior experience with the braille code; rather, we directly assessed braille skills during a pretest (described below). We recruited all participants through the Psychology Department experiment research pool; each participant received research credits as compensation for participation. These research credits could be exchanged for extra credit in some departmental courses. Participants volunteered for the experiment using an on-line scheduling system. We required the students to sign up for two sessions. We used the first session for the formal evaluation of the instructional program. We arranged the second session 7 to 14 days after completion of the initial session to assess the maintenance of braille skills. We later rescheduled some time slots due to missed appointments.

Procedure Overview

The experiment took place in an office on the Louisiana State University campus. A schematic of the pretest and training procedures is shown in Figure 1. Participants began their first session by reading and signing an informed consent document that explained the procedures and purpose of the study. They also completed a brief demographics form. To ensure their reading fluency, we asked participants to read a sixth-grade passage from the Oral Reading Fluency (ORF) subtest of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminski, 2007) because this is the most advanced grade level the test offers. We also assessed their braille reading ability by asking them to read a first-grade passage from

Figure 1. Representation of the sequential flow of procedural events.

the same assessment that we transcribed into braille (see example in Figure 2). We asked participants to read this passage visually; we did not assess tactile braille reading at any point. We created the instructional program using PracticeMill software (Peladeau, 2000); participants completed the training on an HP mini laptop computer running Microsoft Windows XP.

Pretest Probes

Printed text reading probe. Before beginning the braille assessment, participants completed

My Rock Collection

I started a rock collection. It began when I visited the coast. There were so many rocks on the beach. They were wet and shiny from the water. They came in many beautiful colors. They were pink, green, black, and white. Some rocks had been worn by the waves. One even had a hole in it. When the rocks dried they were not so colorful.

I STARTED A BOMI COLLECTION IN
 1969 WHEN I VISITED THE COUNTRY.
 THERE WERE 20 BOMI BOWLS IN THE
 PALACE, EACH WITH ONE OR TWO FROM
 THE OTHER. EACH WITH AN OWN
 HISTORICAL COLOR. EACH WITH A
 GREEN, BLUE, OR WHITE. SOME BOWLS
 HAD TWO OR MORE IN THE SAME ONE COLOR.
 AND A BOWL IN IT. EACH THE BOWLS
 THING THAT WERE NOT SO COMMON.

Figure 2. Sample of reading material for the pre- and posttest reading probes in standard English text (top) and transcribed into braille (bottom).

the prerequisite reading assessment; the experimenter scored the passage using the criteria described in the DIBELS manual (Good & Kaminski, 2007). The experimenter instructed the participant to read the passage as quickly and accurately as possible in 1 min. We set the prerequisite requirement at least at the sixth-grade level, determined by at least 125 words read correctly in the 1-min time limit. This criterion is the benchmark for “not at risk” in the progress-monitoring scoring protocol included in the DIBELS assessment. All participants exceeded this benchmark.

Braille reading probe. For the pretest braille reading probe, the participants were given the braille passage and were asked to read every word of the passage aloud, to skip any unknown words, or to state that they could not read the passage. The experimenter scored these probes by reading along on a second, printed-word version of the passage. The session ended when (a) the participant stated that he or she could not read any of the passage, (b) the participant attempted to read but did not read any word correctly after the first line, or (c) after 5 min of reading, whichever occurred first. If any participant had a correct response during this

phase, we would have excluded him or her from further participation.

Instruction Program

Prior to initiating instruction, we conducted a pretest of matching the 26 letters of the English alphabet to their braille counterparts using the computer-based format. The layout of the screen included a braille character as a sample stimulus and five or six English-letter multiple-choice options as the comparison array (see Figure 3, top, for an example). During this pretest, participants had only one opportunity per session to identify the correct letter; the program did not provide any feedback for correct or incorrect responses. The participant responded by clicking the radio button adjacent to the comparison stimulus (printed letter); after the selection response, the next question automatically appeared. The program did not have a time limit for each item; the individual worked at his or her own pace and moved between questions at differing speeds. The program presented each letter once during each pretest session, resulting in 26 trials per session. We staggered the initiation of instructional sessions in a nonconcurrent multiple baseline design across participants.

Figure 3. Print screen of the PracticeMill computer program. The top image is the display of a training session, identical to the pre- and posttest letter-acquisition assessments with the exception of the bottom bar listing the correct and incorrect responses removed. The bottom image is an example of corrective feedback contingent on an incorrect response during training.

After the pretest, we randomly divided the alphabet into five-letter sets with five or six letters in each set. We arranged each letter set into one of five training units. Each session of a training unit included three presentations of each target letter as a sample stimulus plus a single presentation of all previously mastered letters as sample stimuli to ensure continued

practice with mastered letters. For example, Unit 1 consisted of the letter set O, G, K, A, and Y, with each letter presented three times. After meeting mastery criterion (two consecutive sessions with accurate responding of 95% or higher), participants began Unit 2. Sessions in Unit 2 included one-trial presentations of each of the letters from Unit 1 (O, G, K, A, and Y) and three-trial presentations of each letter in the new set (D, V, S, H, and T). Members of each training set were interspersed randomly across trials. The comparison stimuli presented with each sample were from the same letter set (e.g., when D was the sample stimulus, only D, V, S, H, and T were presented as comparisons) to avoid the possibility of exclusion learning (Toussaint & Tiger, 2010). The participant did not have access to later units until he or she completed the earlier units at mastery levels.

Presentation of instruction sessions was similar to pretest sessions, except that in addition to presenting the letters in sets, the program provided immediate feedback following each response. If the participant selected the correct comparison, the feedback "great!" appeared on the screen, along with a prompt for the participant to press the space bar to continue to the next item. If the participant selected the incorrect comparison, an immediate auditory beep sounded, and a message appeared on-screen with corrective feedback (e.g., "No. The correct answer is K"). After this immediate corrective feedback (see Figure 3, bottom, for an example), the same stimulus was presented; this required the participant to select the correct comparison before he or she could advance to a new trial. We did not include responding during these error-correction trials in the subsequent data analysis.

After mastery of the last unit, the participant completed a posttest letter-identification assessment that was identical to the pretest probe (i.e., all 26 letters presented one trial each without response feedback). We then also

conducted a posttest of braille reading by asking the participant to read the same transcribed DIBELS passage that had been presented in the pretest using the same 5-min time limit and scoring criteria.

Maintenance Probes

Each participant returned for a maintenance session. Three participants returned in the planned 7 to 14 days following the initial training session. One participant encountered scheduling difficulties and completed the maintenance session 24 days after initial training. Participants again completed the letter-identification and braille-reading probes in a fashion identical to the pre- and posttest probes, but with a new ORF passage from the DIBELS (to prevent practice effects). These passages are designed to be of equivalent difficulties with an alternate-form reliability ranging from .89 to .94 (Good & Kaminski, 2007). Therefore, this difference should not inhibit comparison between the posttest and maintenance probes.

Measurement and Interobserver Agreement

In scoring the letter-identification and braille-reading probes, the experimenter left blank the words read correctly and placed a slash through any word that was read incorrectly or not read. If a student misread a word and self-corrected the word before moving on, it was marked with an SC and counted as a correct word. At the end of the assessment, a bracket was placed around the last word read correctly to denote the end of the reading assessment. The passages were scored by counting the total number of words read correctly and the number of errors (words read incorrectly without a self-correction or skipped).

A second observer independently scored, either simultaneously or from an audiotaped version of the session, 31% of the reading probes. Interobserver agreement was calculated by comparing the two observers' recordings on a word-by-word basis. Each word was scored in

agreement if both observers scored a word identically or in disagreement if the observers did not mark the same response for a word. We then summed the number of words in agreement, divided this sum by the total number of words read (if the total number of words read in the time limit differed between the two observers, we used the larger number of words recorded for this calculation), and converted this quotient into the percentage of words agreed on. Mean interobserver agreement was 96% (range, 82% to 100%). The PracticeMill software automatically scored and reported participants' responding during the pre- and posttest letter-identification probes and the instructional procedures and recorded the time spent in training; no interobserver agreement assessments were necessary.

RESULTS

Training Sessions

Maureen (Figure 4) accurately selected printed letters given a braille sample during a mean of 19% of trials in her single pretest session (chance levels given five comparison stimuli). She then began the training program and mastered each of the five instructional units in 15 total sessions. The total instructional time from the point at which she started the instructional program (not including the pretest letter-identification and reading probes) to the point at which she completed her final session of Unit 5 was 18 min and 50 s. After completing training, her letter accuracy increased to 100% during the posttest.

Rick (Figure 4) accurately selected printed letters given a braille sample during a mean of 27% of trials in three pretest sessions. He then began the training program and mastered each of the five instructional units in 20 total sessions. The total instructional time from the point at which he started the instructional program (not including the pretest probes) to the point at which he completed his final session of Unit 5 was 18 min and 30 s. After

completing training, his letter accuracy increased to 100% during the posttest.

Sarah (Figure 4) accurately selected printed letters given a braille sample during a mean of 16% of trials in five pretest sessions. She then began the training program and mastered each of the five instructional units in 23 total sessions. The total instructional time from the point at which she started the instructional program (not including the pretest probes) to the point at which she completed her final session of Unit 5 was 22 min and 37 s. After completing training, letter accuracy increased to 100% during the posttest.

Amy (Figure 4) accurately selected printed letters given a braille sample during a mean of 30% of trials in seven pretest sessions. She then began the training program and mastered each of the five instructional units in 23 total sessions. The total instructional time from the point at which she started the instructional program (not including the pretest probes) to the point at which she completed her final session of Unit 5 was 37 min and 46 s. After completing training, letter accuracy increased to 88% during the posttest.

In summary, all participants successfully met mastery of all five units in a mean of 20.25 sessions (range, 15 to 23 sessions) in a mean of 24.4 min (range, 18.5 min to 37.8 min). Maureen, Rick, and Sarah each responded at 100% accuracy in the posttest probe conducted immediately after completion of the training program; Amy responded at 88% accuracy (it is worth noting that Amy experienced the longest pretest period, with seven pretest probes prior to initiating instruction; anecdotally, she appeared to be fatigued by the end of her session). Maureen and Sarah continued to respond with 100% accuracy on the maintenance probe, whereas Rick's and Amy's accuracy decreased to 61% and 81%, respectively. Although Rick's performance was the lowest at maintenance, it is worth noting that he was the participant who returned after 24 days.

Figure 4. Percentage of braille letters correctly identified across experimental phases for each participant.

Figure 5. Number of braille words read correctly and incorrectly for all four participants during pretest, posttest, and maintenance braille reading probes.

Braille-Reading Probes

The results from the three braille-reading probes for each participant are depicted in Figure 5. None of the participants read a braille word correctly during the initial pretest probe. After training, Maureen, Rick, Sarah, and Amy read 21, 38, 19, and 2 words correctly, respectively, immediately after the computer-based instruction on the posttest probe and 23, 10, 7, and 0 words correctly, respectively, on the maintenance probe. Thus, the brief computer-based instruction was not only sufficient to develop high accuracy in braille-to-printed-letter matching, but also resulted in an emergent relation of reading some braille words from the passage.

DISCUSSION

We successfully taught four college students to match braille characters to their corresponding printed letters via a computerized instructional program. Participants required a mean of 24.4 min to complete this program. At the conclusion of participation, each participant not only accurately identified each braille character but also demonstrated an emergent braille-reading

skill, albeit a fairly weak repertoire. Both skills were maintained for 7 to 24 days (with the exception of reading for Amy). These results demonstrate a novel, efficient, computer-based means of teaching the relation of braille characters to printed letters.

These results were similar to those reported by Toussaint and Tiger (2010), in that teaching the braille-to-printed-letter relation to sighted readers resulted in the emergence of additional relations that are important to the development of braille literacy, but they extend the results of Toussaint and Tiger in several important ways. First, the current study included an adult population (rather than children with degenerative visual impairments who had prior braille experience in the previous study). We selected college students because of their demographic similarities to the teachers who ultimately would be targeted by this instructional program (i.e., practicing teachers or college students in special education preparatory programs). It is notable that none of our participants reported prior exposure to the braille code, yet they completed the full training program in a mean of about 25 min. It is not clear at this point, given our small sample size, if this level of efficiency is

representative of all learners; we currently are replicating these procedures with larger numbers of undergraduates to answer this question.

Second, the current study differed in that our participants responded to visual presentations of braille stimuli, whereas the participants in Toussaint and Tiger (2010) learned to respond to tactual braille. As noted previously, the required repertoires of braille instructors differ in this regard relative to their visually impaired students; it is more important for teachers to read braille visually than tactually. However, it would be interesting from a conceptual perspective to assess the emergence of tactual braille reading given this training. It is possible, although we did not assess it, that relations would have emerged between visual and tactual braille following this instruction (see Bush, 1993, for an example).

Third, we demonstrated that braille reading emerged after instruction in letter matching. This can be considered a transitive relation among not only the printed letters, the braille characters, and the letter names, but also their individual phonemic sounds and the manner in which they are blended when combined with other characters. This is important from a conceptual level (i.e., the demonstration of a transitive relation), but it also provides perhaps the most important applied contribution of this study. That is, this brief computer-based instruction was sufficient to generate an inchoate braille-reading repertoire. It is important to note that our participants were not fluent braille readers; our peak performance at the immediate posttest was 38 words in 5 min, which was well below fluency. Although specific guidelines for components of braille fluency have not been established, researchers have suggested that the components may be similar to those included in literacy for visual students (Erickson & Hatton, 2007). Therefore, practice and feedback likely would be needed to achieve fluency, but the current program appears to be both an efficient and effective first step toward this goal.

Fourth, our current instructional program was developed using a computer-based model

rather than the printed cards used by Toussaint and Tiger (2010). Computer-based instruction permitted greater consistency in stimulus presentation, automated scoring and record keeping, minimized concerns regarding procedural integrity, and eliminated the need to train instructors to implement this program. Further, a computer-based model permits administration via the Internet. As pointed out by Johnson (1996), there is a lack of well-trained instructors for the visually impaired as well as a deficit in the number of programs to prepare instructors; this limited number of programs makes qualified instructor access a challenge. We are hopeful that a Web-based version of this instructional procedure will address some issues of access; we currently are developing a Web-based version of this program for evaluation.

This study creates a number of important avenues of future research. First, our program targeted only letters in the braille code; additional programming will be necessary to teach braille punctuation, grammar, proofreading, and rules about common braille contractions (frequently referred to as Level 2 or contracted braille) to target skills addressed by the test for instructors of the visually impaired (National Blindness Professional Certification Board, 2009). Second, we randomly assigned letters to training units in the current study, but it is possible that a more thoughtful arrangement of letters could facilitate the formation of discriminations. In particular, certain braille characters appear to be very similar (e.g., I and E; see Figure 6 for the corresponding braille characters). Systematic pairing of the most similar stimuli may promote more fine discriminations. Future evaluations will be necessary to determine if this is the case.

It also would be interesting to determine if requiring a constructed response in lieu of a selected response (i.e., typing the letter in lieu of selecting the letter in a multiple-choice format) facilitates generalization and maintenance of learning. For example, Tudor (1995) found that

A ·	B :	C ¨	D ¨	E ¨
F ¨	G ¨	H ¨	I ¨	J ¨
K :	L :	M ¨	N ¨	O ¨
P ¨	Q ¨	R ¨	S ¨	T ¨
U ¨	V ¨	W ¨	X ¨	Y ¨
Z ¨				

Figure 6. Each English letter corresponding to its braille character.

constructed responding improved the effectiveness of a computer-based program relative to a multiple-choice format. Several studies have suggested that having participants generate a response from all items in a stimulus class (e.g., the entire alphabet), as opposed to choosing a response from a limited subset of the stimulus class (e.g., five multiple-choice options from the alphabet), can improve performance on posttests. This often is termed the *generation effect* and has been seen especially when stimuli that frequently occur in the individual’s environment are included (Hirshman & Bjork, 1988). We currently are analyzing this by manipulating the response method (i.e., multiple choice or constructed response) and comparing the time in training and reading performance at posttest and maintenance assessment.

It is worth noting that we did observe decrements in participants’ braille reading on the maintenance probes for each participant. In one sense, it can be taken as a testament to the strength of the equivalence class that these untrained relations were maintained at any level days after only 25 min of instruction. More practically though, the maintenance data highlight that continued skill performance and reinforcement (ideally derived from natural

sources) will be necessary to promote long-term maintenance of this skill. Future research will be needed to determine the necessary conditions to maintain and enhance reading fluency following this initial instruction.

This study demonstrated the effectiveness of a computer-based program for instruction of the relation between printed letters and braille characters. In our population of sighted adults, this trained relation also led to the transitive relation of braille reading. This is a valuable extension of past research, in that it creates a training program that can be easily accessible to a large number of people from any location.

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