

Comparison of Vocabulary Instruction Strategies  
for Students who Read Braille

By

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# TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS .....	ii
LIST OF TABLES .....	v
LIST OF FIGURES .....	vi
Chapter	
I. Introduction.....	1
Vocabulary Instruction.....	2
Braille, Vocabulary, and Spelling.....	3
Present Study .....	5
II. Method .....	7
Participants.....	7
Setting .....	7
Materials and Word Selection.....	9
Response Definitions and Measurement Procedures.....	11
Interobserver Agreement .....	16
Experimental Design.....	16
Pretests .....	17
Procedures.....	18
Procedural Fidelity.....	21
Social Validity .....	22
III. Results.....	23
Results for Peter.....	24
Results for Helen.....	29
Results for Vincent .....	33
Interobserver Agreement and Procedural Fidelity.....	37
Social Validity .....	38
IV. Discussion .....	40
Definition Recall.....	40
Spelling .....	41
Limitations .....	43
Implications.....	44

	Page
Appendix	
A. Sample Data Collection Forms .....	46
B. Interobserver Training Scoring Definitions .....	51
C. Generalization Stories .....	53
REFERENCES .....	57

## LIST OF TABLES

Table	Page
1. Some Braille Symbols and Meanings.....	4
2. Description of Participants.....	8
3. Final Word Sets, Definitions, and Sentences for Peter.....	12
4. Final Word Sets, Definitions, and Sentences for Helen.....	13
5. Final Word Sets, Definitions, and Sentences for Vincent.....	14
6. Number of Sessions to Mastery.....	23
7. Average Time per Session.....	24
8. Spelling Responses for Select Sessions for Peter.....	28
9. Spelling Responses for Select Sessions for Helen.....	32
10. Spelling Responses for Select Sessions for Vincent.....	36
11. Average IOA Across Participants and Conditions.....	37
12. Average PF Across Participants and Conditions.....	38

## LIST OF FIGURES

Figure	Page
1. Percentage of Target Word Definitions Recalled Correctly for Peter .....	25
2. Percentage of Target Words Spelled Correctly for Peter.....	27
3. Percentage of Target Word Definitions Recalled Correctly for Helen.....	30
4. Percentage of Target Words Spelled Correctly for Helen .....	31
5. Percentage of Target Word Definitions Recalled Correctly for Vincent.....	34
6. Percentage of Target Words Spelled Correctly for Vincent .....	35

## CHAPTER I

### INTRODUCTION

The National Institute of Child Health and Human Development (NICHD, 2000) identified three categories of skills necessary for reaching reading proficiency: (a) alphabetics, (b) fluency, and (c) comprehension. Comprehension is often seen as the ultimate goal of reading instruction. In fact, the National Reading Panel wrote, “Comprehension is critically important to development of children’s reading skills and therefore their ability to obtain an education” (NICHD, 2000, p. 4-1). However, it is important to understand that multiple distinct cognitive processes interact to create the construct we commonly refer to as reading comprehension.

Perfetti, Landi, and Oakhill (2005) created a cognitive model of reading that recognizes the interactions between a written text, word identification, comprehension, and background knowledge. Word identification refers to bottom-up processes necessary for decoding to occur, (e.g., phonological awareness skills). Comprehension processes are top-down processes involved in creating a global context, or situation model, from which meaning is extracted. Background knowledge reflects any and all information readers possess that might influence their efficiency in the other two areas, such as oral language skills and vocabulary. In a recent review, Savaiano, Compton, and Hatton (2014) used the Perfetti et al. (2005) model to frame existing braille reading research. They highlighted that the majority of researchers of braille reading have concentrated on word identification level processes, specifically focusing on the perceptual features of the braille code itself and the rate at which students can decode braille. The area with the least amount of research was background knowledge. In fact, Savaiano et al. found no

research explicitly addressing the importance and role of background knowledge in the braille reading process.

A key element of background knowledge is vocabulary. While decoding is an integral part of the reading process, it is only helpful for comprehension if the resulting word is part of the reader's vocabulary (NICHD, 2000). The age of onset of blindness, visual diagnosis, and presence of additional disabilities are only a subset of factors that could potentially affect the quality and quantity of early learning experiences of braille readers. There is a reciprocal relationship between vocabulary, comprehension, and amount of reading (Nagy, 2005). Fewer experiences lead to less complete general background knowledge and vocabulary to draw upon during word identification. Students who read braille have less exposure to text, which affects vocabulary acquisition (Savaiano et al., 2014).

### **Vocabulary Instruction**

Vocabulary may be taught directly and indirectly (NICHD, 2000). However, research has shown that direct instruction is more effective for teaching word meanings (Jitendra, Edwards, Sacks, & Jacobson, 2004; Marulis & Neuman, 2010). During direct instruction, vocabulary is taught through an explicit presentation of a target word and its definition. This strategy was found to be more effective than learning words in context (Pany & Jenkins, 1978; Pany, Jenkins, & Schreck, 1982) and was also helpful in making decoding more meaningful by adding to the oral language of the reader (NICHD, 2000).

To store words in memory for later use and retrieval, associations are formed between the spelling, pronunciation, and meaning of a word (Ehri & Rosenthal, 2007). This way, when a word is read aloud, the pronunciation of the word triggers the association with its meaning. Likewise, when a word is read silently, the spelling of the word triggers the association. This

association, when utilized during instruction, has proven to help children remember the meanings of words. Rosenthal and Ehri (2008) taught unfamiliar words to groups of 2<sup>nd</sup> and 5<sup>th</sup> grade children by defining words, depicting words, and using words in sentences, all elements of direct instruction. One set of words had the spellings visible, and the other set did not. The spellings helped students remember the meanings of words compared to the words without spellings. Although this association has the potential to facilitate the efficiency of word learning, written words are not often included in vocabulary instruction (Ehri & Rosenthal, 2007).

Repeated exposures to targeted words is a component of vocabulary instruction highlighted by the National Reading Panel (NICHD, 2000), and including the spellings of words during instruction is a simple method for incorporating this component. From the little we know about braille reading, it seems reasonable to presume that children who read braille would benefit from this type of instruction.

### **Braille, Vocabulary, and Spelling**

Braille is an embossed code in which each unit (i.e., braille cell) is made from a combination of six dots. There are two forms of braille: uncontracted and contracted. Uncontracted braille assigns a unique dot configuration to each letter in the English alphabet. There is a one-to-one correspondence between letters and braille cells. Contracted braille represents common whole words and common letter combinations with one or more braille cells, removing the one-to-one correspondence between print letters and braille characters. Consisting of only six dots, there are limited configurations for braille characters. As a result, many braille contractions share the same shape but in a different location within the cell (see Table 1). Some braille contractions even share the exact same configuration, requiring syntax and context to discriminate the character.

Table 1

*Some Braille Symbols and Meanings*

<b>Braille symbol</b>	<b>Meaning(s)</b>
	h
⠠	have 8 (literary code)
⠠⠠	here
	his
⠠	8 (math code) ? (question mark) “ (opening quotation mark)

As the individual characters become more difficult to discriminate, words become harder to read, because the unit of recognition in braille is the individual braille character (Nolan & Kederis, 1969). This sequential, one cell at a time, perception may strain orthographic and phonological processing (Adams, 1990). Unfortunately, the body of research on teaching reading to children who read braille is limited (Savaiano et al., 2013).

The Alphabetic Braille and Contracted (ABC) Braille Study was a prospective nonrandomized, five-year descriptive longitudinal study between 2002 and 2007. From these data, Wall-Emerson, Holbrook, and D’Andrea (2009) found vocabulary, measured by the Brigance Comprehensive Inventory of Basic Skills (Brigance, 1999), to be highly correlated with overall reading ability, as measured by the Johns Basic Reading Inventory (Johns, 2001). The majority of participants were performing on or above grade level in spelling. Descriptive statistics supported the conclusion that participants using uncontracted braille had poorer vocabulary and lower reading levels than participants in similar grades using contracted braille. In the last year of the study, 47.2% of participants were performing below grade level in

vocabulary, and, across all years of the study, approximately 60% of participants were reading below grade level.

As far as we know from recent research, braille use does not affect spelling ability (Clark & Stoner, 2008; Clark-Bischke & Stoner, 2009; Wall-Emerson et al., 2009). Clark and Stoner (2008) administered the Test of Written Spelling (Larsen, Hammill, & Moats, 1999) and compared scores to the normative sample. Results showed that braille users had scores similar to the general population, as defined by the normative sample. However, Clark and Stoner's sample only included 23 participants. This sample size was not comparable to the size of the normative sample, and these 23 participants may not be representative of the general population of braille readers.

Clark-Bischke and Stoner (2009) did not include a comparison group in their examination of spelling. They calculated the number of words spelled correctly within participants' authentic writing samples to make comparisons between age levels of braille users. They found no consistent increase in number of words produced or in percentage of words spelled correctly as participant age increased. However, Clark-Bischke and Stoner eliminated braille errors from their spelling analysis. They reported a total of 32 braille errors, but omitted them before calculating the number of words spelled correctly. These omissions were made on the theory that braille errors relate to the mechanics of written braille, rather than English spelling conventions. However, if words with braille errors were transcribed into print they would be misspelled. Failing to consider these errors as errors of spelling may have skewed the results.

### **Present Study**

The present study examined whether the presence of a target word in braille facilitates vocabulary acquisition. To address this question, two instructional conditions were compared to

determine whether a flashcard instructional condition was more effective than an auditory only instructional condition. The flashcard strategy had four components: (a) the target word was presented in braille on a flashcard, (b) the target word was spoken aloud, (c) the target word was used aloud in a sentence, and (d) the target word definition was spoken aloud. Auditory only vocabulary instruction for students who read braille involved verbal/auditory instruction, in which words and their definitions are spoken aloud without being presented in braille (components b-d). Specifically, this study addressed the following research question: Do students who are blind learn (1) the meanings of words in fewer sessions and (2) to spell words more accurately via flashcard vocabulary instruction compared to auditory vocabulary instruction?

## CHAPTER II

### METHOD

#### **Participants**

To be included in the study, students had to (a) be diagnosed with a visual impairment, (b) read braille at a second grade level, (c) be enrolled in grades 3-6, (d) speak English as their primary language, and (e) have hearing within normal limits. Students were excluded if they had a motor impairment that impacted their ability to read or write braille with two hands. Students diagnosed with additional disabilities who met all criteria listed above were included in the study. Seven students and their caregivers were consented for this study, and four were excluded because they did not meet the grade level reading criterion. Three participants were recruited from a residential school for the blind for this study (see Table 2). Peter and Helen were primarily day students, although Helen stayed 2 nights and Peter stayed 3 nights a week on campus in the residences. Vincent was a residential student, meaning he would arrive on campus Sunday evening.

#### **Setting**

The study was conducted in the students' regular classrooms. The investigator sat next to students at a designated table within the classroom separate from the students' desks. The procedural fidelity observer, when present, was seated behind the student and the investigator or, when space was available, seated next to the student and the investigator. The table was an appropriate height for all students and had enough surface area to accommodate study materials (i.e., rubber mat, braillewriter, and audio recorder).

Table 2

*Description of Participants*

	<b>Peter</b>	<b>Helen</b>	<b>Vincent</b>
Age (in years)	12.7	11.1	9.5
Classification	MD: 1. Blind 2. LD	Blind (recertified from MD)	MD: 1. Blind 2. LD 3. OHI 4. Autism
Visual Diagnosis	Bilateral Anophthalmia	Optic Nerve Hypoplasia	Retinopathy of Prematurity
Visual Acuity	NLP (O.U.)	NLP (O.S.) LP - possibly (O.D.)	LP (O.U.)
Developmental Spelling Level	Syllable Juncture	Syllable Juncture	Syllable Juncture
Braille Contractions	131/189 (69%)	168/189 (89%)	169/189 (89%)
WJ-III Braille Adaptation	Letter-Word ID = 2.5 GE Passage Comp. = 1.9 GE Word Attack = 2.5 GE	Letter-Word ID = 4.9 GE Passage Comp. = 2.1 GE Word Attack = 14.8 GE	Letter-Word ID = 3.2 GE Passage Comp. = 2.1 GE Word Attack = 2.8 GE
WISC-IV	Verbal Comp. = 68 Working Memory = 80 Verbal Deviation = 68	Verbal Comp. = 81 Working Memory = 68 Verbal Deviation = 73	Verbal Comp. = 93 Working Memory = 88 Verbal Deviation = 90

*Note:* MD = multiple disabilities; LD = learning disabilities; OHI = other health impaired; NLP = no light perception; O.U. = both eyes; O.S. = left eye; LP = light perception; O.D. = right eye; WJ-III = Woodcock-Johnson III Tests of Achievement; GE = grade equivalent; WISC-IV = Wechsler Intelligence Scale for Children IV

## **Materials and Word Selection**

There were three word sets for each participant (flashcard, auditory, control), with six words in each set. Word sets were made as comparable as possible by taking lexical characteristics into consideration. The procedures for creating word sets (including the selection of definitions and creation of sentences) are detailed below. Words for the flashcard condition were brailled onto 2x3 cards. These flashcards were identical to cards used during classroom word study instruction. The top right corner of each index card was cut at an angle to facilitate correct orientation of the cards. In addition, a rubber mat was used to prevent flashcards from sliding while being used, and an Olympus digital voice recorder was used to record audio from all sessions.

**Creating word lists.** Initial word lists were created from The Living World Vocabulary (Dale & O'Rourke, 1981). A random number generator was used to select pages from The Living World Vocabulary. Words with multiple entries (i.e., multiple definitions) were omitted. Lists were then entered into The English Lexicon Project (Balota et al., 2007) and the Medical Research Council (MRC) Psycholinguistic Database (Coltheart, 1981) to generate the desired lexical characteristics: (a) number of letters, (b) orthographic Levenshtein distance, (c) phonological Levenshtein distance, (d) number of phonemes, (e) number of syllables, (f) number of morphemes, (g) part of speech, (h) concreteness, and (i) imageability. A research assistant entered the generated items into a database and manually entered grade level and frequency as reported in The Living World Vocabulary. I checked 25% of the research assistant's entries, and we had 100% agreement. A total of 967 words were entered in the database, and only 131 words had a score for imageability or concreteness. The scales for imageability and concreteness were integers from 100 to 700. There was no criterion set for inclusion; words had to have a score

recorded for at least one of the scales. These 131 words were sorted by grade level and used as the pool from which word sets were created.

**Word selection.** The master word list was sorted by grade level and words from the appropriate grades were provided to students' teachers. Teachers were asked to select words from the list that were likely to be unknown to the student. They were also asked to only highlight words they felt were appropriate for the student to learn. Teacher-selected words were given preference when creating word sets. There were several instances when teacher-selected words were not used in the final word set because (a) the definition could not be reduced to five words and retain clarity (e.g., aspect, see procedures for selecting definitions below), (b) the definition included the word or part of the word (e.g., millstone, see procedures for selecting definitions below), (c) the word was a homophone for a more common word (e.g., rein), (d) the word was self explanatory (e.g., lowland), or (e) the student knew the meaning of the word. The teachers approved all researcher-selected words.

**Selecting definitions.** Once the teacher-selected words were received, definitions were culled from three sources: The Living World Vocabulary (Dale & O'Rourke, 1981), Merriam-Webster's Word Central (2014), and the Merriam-Webster Learner's Dictionary (Mairs, 2014). The Living World Vocabulary provides a succinct definition for every entry, but these definitions were sometimes at a high readability level. Word Central is a student dictionary that provides short, simple definitions. The Learner's Dictionary was created for students learning English as a second or foreign language, and it provides clear, illustrative definitions. Between these three sources, definitions were selected to be clear and concise. Words were eliminated if they could not be defined using five or fewer words or the definition needed to include the word or part of the word.

**Creating word sets.** The initial 18 words for each participant (six words in each word set) were chosen randomly from the pool of words remaining after teacher selection and definition selection. The lexical characteristics for each word were entered into SPSS (IBM, 2012), and words in each set were compared using ANOVA with a Bonferroni correction to control for multiple comparisons. These initial word sets were adjusted so there were no significant differences between groups on any of the lexical characteristics. For Helen and Vincent the initial word sets were also the final word sets, because they did not know the meanings of any words during initial probe (see procedures for initial probe for more detail). Peter knew the full or partial meaning of three words from the initial word sets (*carnation*, *imagination*, and *squirm*). These words were replaced, statistical analyses were rerun, and word sets were adjusted to maintain comparability. Peter's third set of words became his final word sets.

**Creating sentences.** Once word sets were finalized, sentences were created for each word. Criteria for sentences were as follows: (a) used the exact form of the word, (b) provided additional context for the word, (c) did not restate the definition, and (d) had ten or fewer words. The principal investigator (PI) created sentences, and her faculty advisor provided independent feedback on clarity, grammar, accuracy, and the aforementioned criteria. Sentences were revised and returned to the faculty advisor for approval. Tables 3, 4, and 5 show the final word sets, definitions, and sentences for Peter, Helen, and Vincent, respectively.

### **Response Definitions and Measurement Procedures**

Data on two dependent variables were collected during each session: definition recall and spelling (see Appendix A). Definition recall was the primary dependent variable and was used to guide experimental design decisions.

Table 3

*Final Word Sets, Definitions, and Sentences for Peter*

Word Set	Words	Definitions	Sentences
A: Flashcard	madame	Mrs. in French	My students call me <u>Madame</u> Savaiano.
	ashamed	feel guilty	I was <u>ashamed</u> of myself for stealing.
	rejoice	feel very happy	We <u>rejoice</u> when the Tigers win.
	chloride	a chemical	The scientist used <u>chloride</u> to make salt.
	shilling	a British coin	A <u>shilling</u> was worth twelve cents.
	interruption	a break	There was an <u>interruption</u> when the phone rang.
B: Auditory	tweed	wool cloth	The man wore <u>tweed</u> pants.
	century	100 years	In one <u>century</u> it will be twenty-one thirteen.
	frantic	feeling fear and worry	She made a <u>frantic</u> search for her lost cat.
	kerchief	a piece of cloth	She had a red <u>kerchief</u> around her neck.
	sufferer	a person with pain	I am an allergy <u>sufferer</u> .
	unnatural	not normal	It was <u>unnatural</u> to have school on Saturday.
C: Control/ Best Alone	peso	Spanish money	A <u>peso</u> is worth seventy-eight cents.
	bravery	courage	The firefighter was awarded for his <u>bravery</u> .
	brawl	a fight	The kids had a <u>brawl</u> over a toy.
	caravan	a traveling group	Ten cars were in the <u>caravan</u> to the circus.
	industrious	hard working	All the students here are <u>industrious</u> .
	turpentine	paint thinner	The painter used <u>turpentine</u> to clean his hands.

Table 4

*Final Word Sets, Definitions, and Sentences for Helen*

Word Set	Words	Definitions	Sentences
A: Flashcard	centennial	100 <sup>th</sup> anniversary	America celebrated its <u>centennial</u> in eighteen seventy-six.
	punctual	on time	It is important to be <u>punctual</u> to class.
	bramble	thorn bush	The gardener removed the <u>bramble</u> .
	defiance	refusal to obey	He was out late in <u>defiance</u> of the rules.
	ashen	very pale	Her face was <u>ashen</u> when she was sick.
	mackerel	kind of fish	The fisherman caught a <u>mackerel</u> .
B: Auditory	indolence	laziness	His <u>indolence</u> stopped him from doing his homework.
	conjugation	the way a verb changes	<u>Conjugation</u> is an important part of reading and writing.
	rancid	spoiled	The <u>rancid</u> food smelled bad.
	chloride	a chemical	The scientist used <u>chloride</u> to make salt.
	mosque	Muslim religious building	Some people pray in a <u>mosque</u> .
	shilling	a British coin	A <u>shilling</u> was worth twelve cents.
C: Control/ Best Alone	persuasive	convincing	He was <u>persuasive</u> and his mom changed her mind.
	wrath	anger	If you cheat you will feel the teacher's <u>wrath</u> .
	fraternal	brotherly	Best friends sometimes feel <u>fraternal</u> emotions.
	fissure	a narrow crack	The <u>fissure</u> in the ground looked very deep.
	immensity	hugeness	The school's <u>immensity</u> made it easy to get lost.
	tweed	wool cloth	The man wore <u>tweed</u> pants.

Table 5

*Final Word Sets, Definitions, and Sentences for Vincent*

Word Set	Words	Definitions	Sentences
A: Flashcard	brawl	a fight	The kids had a <u>brawl</u> over a toy.
	frantic	feeling fear and worry	She made a <u>frantic</u> search for her lost cat.
	frail	weak	The <u>frail</u> man could not lift his bag.
	centennial	100 <sup>th</sup> anniversary	America celebrated its <u>centennial</u> in eighteen seventy-six.
	diversity	variety	There is a <u>diversity</u> of students in the school.
	ashen	very pale	Her face was <u>ashen</u> when she was sick.
B: Auditory	caravan	a traveling group	Ten cars were in the <u>caravan</u> to the circus.
	bramble	thorn bush	The gardener removed the <u>bramble</u> .
	immense	huge	It is easy to get lost in this <u>immense</u> school.
	defiance	refusal to obey	He was out late in <u>defiance</u> of the rules.
	deface	ruin the surface	We will <u>deface</u> the desk by scratching it.
	wrath	anger	If you cheat you will feel the teacher's <u>wrath</u> .
C: Control/ Best Alone	reliable	dependable	A judge needs <u>reliable</u> information to make a decision.
	shilling	a British coin	A <u>shilling</u> was worth twelve cents.
	dual	having two parts	A <u>dual</u> media learner reads braille and print.
	persuasive	convincing	He was <u>persuasive</u> and his mom changed her mind.
	sprint	a fast run	He won by making a <u>sprint</u> for the finish.
	rancid	spoiled	The <u>rancid</u> food smelled bad.

**Definition recall.** Definition recall refers to the ability to produce the meaning of a target word when prompted with the question, “What does [word] mean?” The vocabulary subtest guidelines from the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003) were used to measure definition recall of target words. A score of 0, 1, or 2 was recorded for each target word. A score of 2 was recorded for correct responses. According to the WISC-IV, a correct response includes any of the following: the definition from instruction, a good synonym of the target word, a category to which the word belongs, or descriptive features of the word. A score of 1 was recorded for marginal or generalized responses. These are responses that were mostly correct, and include any of the following: a vague synonym, an example using the word, or a definition of a related form of the word. A score of 0 was recorded for incorrect responses, no response, gestural responses with no verbal elaboration, or a response of “I don’t know.” If an acceptable response was accompanied by an incorrect response, a score of 0 was recorded. If responses of different quality were provided at one time, and none were incorrect, the best response was scored. If the participant responded with the definition of a word anytime during probe, the response was scored. Percentage of words correct was the primary dependent variable.

**Spelling.** Spelling refers to the ability to write a word in braille using the correct letters and contractions. A score of 0, 1, or 2 was recorded for each target word. A score of 2 was recorded for correct spellings using all appropriate letters and contractions. A score of 1 was recorded for spellings that were correct, but did not include appropriate contractions. For instance, if the word *sing* were spelled *s-i-n-g* (⠠⠠⠠⠠) instead of *s-ing* (⠠⠠⠠), which uses the contraction for *ing*, it would be scored as a 1. A score of 0 was recorded for words that were spelled incorrectly. Percentage of words spelled correctly was the secondary dependent variable.

## **Interobserver Agreement**

Independent coders were trained to collect interobserver agreement (IOA) data for both dependent variables (definition recall and spelling) from audio recordings of sessions and student artifacts. Coders were trained using audio recordings and artifacts created by the PI. Scoring definitions for definition recall were refined through the training process (see Appendix B), and training continued until coders reached 90% agreement with the PI on both dependent variables.

Independent coders scored definition recalls and spellings for each word set. A point-by-point method was used to calculate IOA for definition recall and spelling. Agreement and disagreement was determined for each target word. The percentage of agreements was calculated by dividing the number of agreements by the total number of agreements and disagreements and multiplying by 100.

Discrepancy discussions occurred whenever there was a disagreement between coders (Yoder & Symons, 2010). When disagreements occurred, the consensus code was recorded and graphed. To retain information from the independent coding, reliability data were collected on the initial coding of the independent observers, not the consensus code. Agreement checks were conducted immediately and consistently throughout the study in order to detect observer drift and independent coders were blind to which word set was assigned to which instructional approach (see Appendix A).

## **Experimental Design**

An adapted alternating treatments design (AATD; Sindelar, Rosenberg, & Wilson, 1985; Wolery, Gast, & Hammond, 2010) was used to compare two strategies for teaching vocabulary words to students who read braille. This design was used to compare the effects of two instructional strategies (flashcard and auditory only) on a nonreversible behavior, learning

vocabulary word definitions. In this study, strategies were alternated within each session. To help control for and detect maturation or history effects, a control word set was probed during the comparison phase (Wolery et al., 2010). In addition, treatment conditions were counterbalanced across sessions to help control for possible sequencing effects.

### **Pretests**

Several pretests were administered to participants individually during the week prior to the start of the study. Due to the number and length of these tests, administration was spread across multiple days. Pretests provided information on students' current level of proficiency with braille, word reading, decoding, and spelling (see Table 1).

**Braille reading.** The EVALS Braille Reading Assessment (Texas School for the Blind and Visually Impaired, 2007) is a checklist used to determine present levels of performance in reading contracted braille. Each word or character from the checklist was brailled onto a 3x5 inch index card with a guide line of dots (Dots 2,5) preceding and following the target word or character. The top right corner of each index card was cut at an angle to facilitate correct orientation of the cards.

**Word reading and decoding.** Several subtests of the Woodcock-Johnson III Normative Update Braille Adaptation (WJ-III BA; Jaffe & Henderson, 2010) were administered to participants prior to the start of the study. The WJ-III BA was not standardized on blind subjects, but the adaptation was completed in collaboration with the Woodcock-Muñoz Foundation to ensure that all adaptations maintain the intent of the original tests. The Word Identification, Word Attack, and Passage Comprehension subtests were administered. Internal consistencies of the measures, based on a normative sample of 8,782 subjects from across the United States, are .94, .87, and .88, respectively.

**Spelling.** The Developmental Spelling Inventory (Ganske, 2000) provided information about students' current levels of spelling ability. Internal consistency of the measure, using coefficient alpha, is .91 for grades 1-4 and .88 for grades 5-8 based on a sample of 1,016 public school students in central Virginia (Ganske, 1999). The inventory was a list of 20 words, which get progressively harder. Words were read aloud, used in a sentence, and repeated. Participants were asked to do their best and to spell the words using their braillewriters.

There were five stages of spelling: emergent, letter name, within word, syllable juncture, and derivational consistency (Ganske, 2000). All three participants fell within the syllable juncture stage of spelling (see Table 2). This stage is characterized by spelling issues concerning multiple syllable words, specifically doubling and vowel patterns in the unstressed syllable (schwa sound).

## **Procedures**

Each condition of the study required participants to respond to a question from the investigator. Participants had 5 seconds to respond. If there was no response after 5 seconds, the investigator repeated the question and waited an additional 5 seconds. If there was still no response, the item was scored as incorrect. Participants were given general reinforcement (e.g., "good job" or "okay") for participation after each response in all phases of the study. Exposures to target words were planned so there would be at least four exposures per session.

**Initial probe (baseline).** During the initial probe, data were collected on students' definition recall and spelling of target words. Data were collected for each participant until a stable baseline for definition recall was established. Because it was critical that participants' did not know the meanings of target words, when a score of 1 or 2 was recorded during initial probe, the word was replaced by a comparable word from the master list. As such, data were collected

using initial probe procedures until three consecutive data points were collected with scores of 0 recorded for all 18 words.

Using a list randomizer from random.org, words were arranged and probed in random order. The investigator and student were seated at a table with a braillewriter loaded with paper on which the date had been typed. To begin probe sessions, the investigator greeted the student and said, “Today I am going to ask you about the meanings of some words, and also how to spell them. You may not know these words, and that’s okay. Just do the best you can.” The student was oriented to the location of the braillewriter. Correct responses were reinforced (Wolery et al., 2010), but procedures for creating word sets ensured that participants did not know any target words in the final word sets.

Each probe followed the same procedures. The investigator asked the student, “What does [word] mean?” If the student responded, “I don’t know”, the investigator said, “That’s okay, just do your best. How do you spell [word]?” If the student provided a response, the investigator provided general reinforcement then continued, “How do you spell [word]?” If the student began to spell aloud, the investigator prompted him/her to write the word using the braillewriter. This procedure continued until all 18 words were assessed. At the end of the session the investigator thanked the student for working with her.

**Comparison.** The comparison condition consisted of instruction using two strategies: flashcard vocabulary instruction and auditory only vocabulary instruction. A control set of words was also probed during this phase, but no instruction took place with this word set. Each session, except the first, included a probe of all three word sets (6 words per set) for definition recall and spelling. All sessions included instruction on two word sets: one using the flashcard strategy and one using the auditory only strategy. The order of instruction was randomly assigned for each

session ahead of time. To begin instruction, the investigator explained, “We are going to learn some words today, and I will ask you about these words tomorrow. Let’s start. The first word is [word]. What is the word?” After the student repeated the target word the investigator provided praise and continued, “[Word] means [definition]. [Uses word in a sentence]. What does [word] mean?” After the student repeated the definition the investigator provided praise and continued to the next word. This procedure continued until both word sets were covered.

The procedure for the flashcard strategy differed slightly. Before the investigator said, “The first word is [word],” she placed a flashcard on the rubber mat in front of the student and said, “Here is the first word.” The flashcard was then present during the instruction outlined above. If the student did not independently move his/her hands across the braille, the investigator prompted him/her to touch the flashcard. Participants were never instructed to “read” the card. When instruction on the word ended, the investigator took the first card back and placed the next flashcard on the mat. Except for the first session in the comparison condition, all target words were assessed at the beginning of every session.

Mastery was defined as 100% words correct (score of 2 for definition recall) for three consecutive sessions. Once mastery was reached in one strategy, the comparison condition continued until (a) the participant reached mastery in the slower strategy, or (b) the slower strategy continued for twice the number of sessions it took the faster strategy to reach mastery (Wolery et al., 2010). The faster strategy was defined as taking fewer sessions to reach mastery. The faster strategy from the comparison condition was used with the control set of words in a best alone condition.

**Best alone.** Procedures for the best alone condition were the same as described above for whichever strategy was determined to be faster. Using the control word set, the best alone condition continued until the participant reached mastery criterion.

**Maintenance.** During the best alone condition, instruction was provided on the control word set using the faster strategy. Instruction on the other two word sets ceased, but the investigator continued to probe definition recall and spelling of all three word sets to provide maintenance data for words taught during the comparison phase. After the best alone condition ended, the investigator continued to probe all three word sets once a week for at least two weeks.

**Generalization probes of definition recall.** After the best alone condition ended, there were three generalization sessions. Generalization sessions took place once per week on days when no maintenance probe occurred. Words from all three sets were used in short passages of no more than five sentences (see Appendix C). Each passage included two words from each word set, for a total of six target words. Each passage was administered in its own session. Sentences were different from those used during instruction, and passages were administered by a research assistant (RA). Participants were instructed to read the passage aloud. At the end of the passage, the RA said, “Thank you for reading to me. You did a really good job. Now I am going to ask you about some of the words you read.” To probe participants’ memory of target word meanings, the RA asked, “In the passage, what did the word [word] mean?” The RA followed the prompting procedures from probe sessions. After all six target words were probed, the RA said, “We are all done. You did a really good job. Thank you for reading to me.”

### **Procedural Fidelity**

Data on procedural fidelity were collected through event recording (Ayres & Gast, 2010). The independent observer recorded occurrence or nonoccurrence of each step of the procedure

(see Appendix A). The average percent fidelity for each step was calculated as the number of observed occurrences divided by the number of expected occurrences, multiplied by 100.

### **Social Validity**

Questionnaires were used to assess teachers' perceptions of the vocabulary instruction at the end of the study (see Appendix A). Questions addressed the importance of vocabulary instruction, procedures used during the study, and effects of the study. Additionally, teachers were asked to provide anecdotal information to explain their choices for most questions.

## CHAPTER III

### RESULTS

Using vocabulary instruction procedures outlined above, three participants who read braille learned the definitions of 18 randomly selected words. Additionally, all three participants learned definitions in fewer sessions to mastery during an auditory only condition. Table 6 presents the sessions to mastery results for all participants. Sessions to mastery were based on participants' ability to learn the meanings of words; however, data were also collected on participants' ability to spell words. Spelling data from all three participants show that exposure to braille flashcards during vocabulary instruction increased students' correct spelling of words.

Table 6

*Number of Sessions to Mastery*

	Peter	Helen	Vincent
Flashcard	6	23	9
Auditory	4	17	7
Best Alone (Auditory)	8	16	6

It is important to note that all participants were able to learn all 18 words, regardless of the instructional strategy used. A functional relation was demonstrated between both instructional strategies and all three participants' definition recall. All three participants reached mastery criterion in fewer sessions during the auditory only condition, even though a clear pattern of differentiation was only evident for two participants' data. Participants learned the definitions of words 2 to 6 sessions faster in the auditory only condition than in the flashcard condition. Therefore, the data suggest that teaching the meanings of vocabulary words to

students who read braille takes fewer sessions to mastery when instruction is auditory only, rather than having a flashcard present during instruction.

Though procedures were uniform across participants (see Appendix A), time per session varied across participants. Overall, sessions with Helen took the least amount of time. Sessions with Vincent were anywhere from 1.5 to 3 times as long as sessions with Helen and Peter during comparison and best alone conditions. Table 7 presents the average time per session for all participants.

Table 7

*Average Time per Session*

Participant	Time in Minutes (Range)		
	Initial Probe	Comparison	Best Alone
Peter	10.5 (9.0 – 12.3) n = 5	12.8 (7.2 – 16.4) n = 6	10.8 (8.9 – 11.9) n = 8
Helen	7.3 (6.5 – 8.6) n = 3	10.5 (6.3 – 13.2) n = 23	10.9 (7.6 – 13.3) n = 16
Vincent	10.4 (9.4 - 12.2) n = 3	21.2 (15.3 – 25.6) n = 9	25.4 (22.5 – 27.7) n = 6

**Results for Peter**

**Definition recall.** Peter learned the definitions of 18 words over 16 sessions and maintained learning at 100%. Figure 1 provides Peter’s percentage of correct definitions recalled (scores of 2). Peter knew the full or partial meaning of two words from the initial word set (*carnation* and *squirm*). These words were replaced, statistical analyses were rerun, and word sets were adjusted to maintain comparability. Peter’s third set of words became his final word sets. Session 6 was the first instructional session, and the probe in Session 7 shows an immediate increase in correct responses for the flashcard condition and the auditory condition.

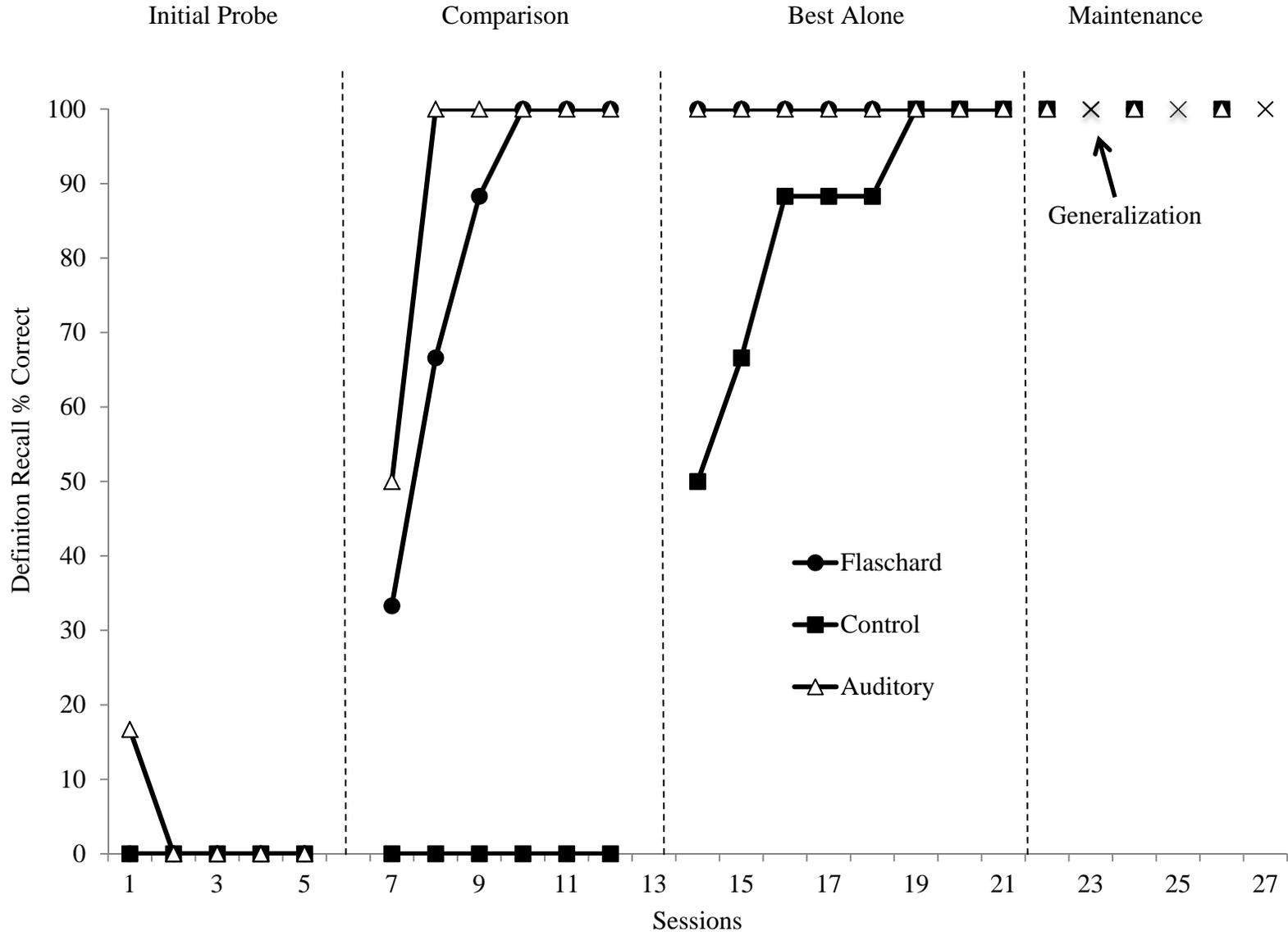


Figure 1. Percentage of target word definitions recalled correctly (score of 2) for Peter.

Peter reached mastery criterion during Session 10 for the auditory condition and during Session 12 for the flashcard condition. When the auditory strategy was used to teach the control set of words during a best alone condition there was an immediate increase in correct responses, and Peter reached mastery criterion during Session 21. Visual analysis shows low, stable performance for both strategies in baseline with an immediate change in level and acceleration toward criterion. While there is only a slight difference in number of sessions to criteria, there is a pattern showing a clear differentiation between the auditory condition and the flashcard condition.

Peter was able to maintain his definition recall regardless of the strategy used as evidenced by continued 100% correct responding for flashcard and auditory sets during the best alone condition, and 100% correct responding for all 3 words sets during maintenance. Additionally, Peter was able to generalize his definition recall to an unfamiliar person during circumstances different than intervention.

**Spelling.** Figure 2 provides Peter's percentage of correct spellings (scores of 2). At the start of the first instructional session, Peter was able to correctly spell two words from each word set (see Table 8). After repeated exposure to braille for the 6 words in the flashcard condition, Peter increased and maintained correct spellings for those words. He did not learn the correct spellings for words in the auditory set or the control set. Visual analysis shows a change in acceleration toward criterion only for words in the flashcard condition.

Table 8 shows a selection of Peter's spelling responses during each phase. During generalization, Peter was exposed to the correct spellings of words from the auditory and control sets. During Sessions 24 and 26, Peter increased correct spellings of words in the control set. Table 8 shows that, overall, Peter remembered certain features of the words, which he

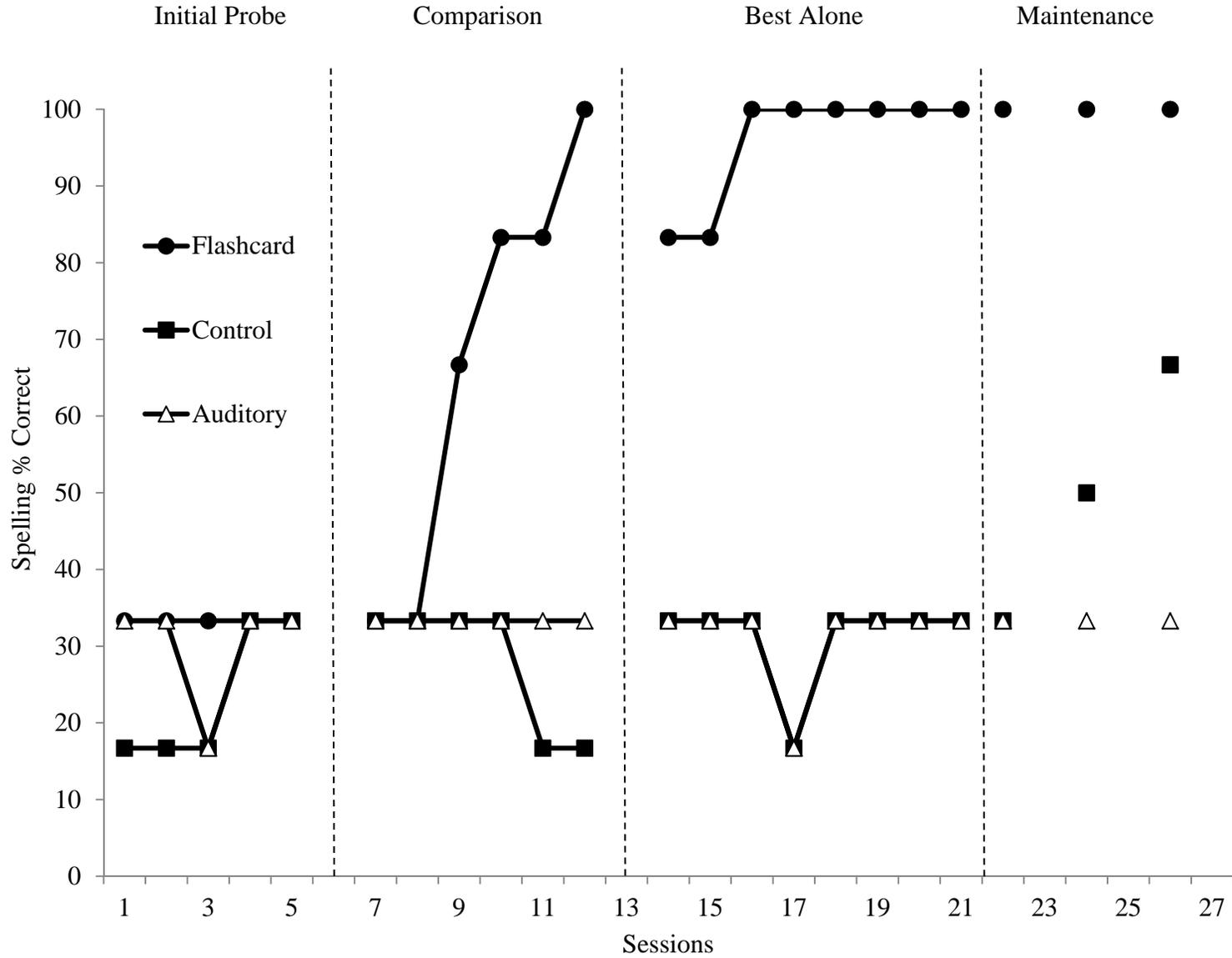


Figure 2. Percentage of target words spelled correctly (score of 2) for Peter

Table 8

*Spelling Responses from Select Sessions for Peter*

Word Set	Correctly Spelled Words <sup>a</sup>	Spelling and Score for Select Sessions <sup>b</sup>							
		Session 5		Session 12		Session 14		Session 26	
Flashcard	madame	mattom	0	madame	2	madame	2	madame	2
	a(sh)am(ed)	a(sh)am(ed)	2	a(sh)am(ed)	2	a(sh)am(ed)	2	a(sh)am(ed)	2
	(re)joice	rejoice	1	(re)joice	2	(re)joice	2	(re)joice	2
	(ch)loride	cloride	0	(ch)loride	2	chloride	1	(ch)loride	2
	(sh)ill(ing)	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2
	(in)t(er)rup(tion)	(in)t(er)ruption	1	(in)t(er)rup(tion)	2	(in)t(er)rup(tion)	2	(in)t(er)rup(tion)	2
Auditory	twe(ed)	twe(ed)	2	twe(ed)	2	twe(ed)	2	twe(ed)	2
	c(en)tury	s(en)tree	0	s(en)tree	0	s(en)tree	0	c(en)trey	0
	frantic	frantic	2	frantic	2	frantic	2	frantic	2
	k(er)(ch)ief	cur(ch)if	0	cur(ch)if	0	cur(ch)if	0	kur(ch)if	0
	su(ff)(er)(er)	suf(er)w(er)	0	suf(er)w(er)	0	suff(er)w(er)	0	suf(er)(er)	0
	unnatural	unnaturl	0	unnaturl	0	unnaturl	0	unnaturl	0
Control	peso	paisoo	0	paisoo	0	paisoo	0	pesoo	0
	brav(er)y	brav(er)y	2	brav(er)y	2	brav(er)y	2	brav(er)y	2
	brawl	brall	0	brall	0	broll	0	brawl	2
	c(ar)avan	c(ar)eavan	0	c(ar)eavan	0	c(ar)eavan	0	c(ar)avan	2
	(in)du(st)ri(ou)s	(in)dustreeus	0	(in)dustreeus	0	(in)dustreeus	0	(in)du(st)reus	0
	turp(en)t(in)e	turp(en)t(in)e	2	t(er)p(en)t(in)e	0	turp(en)t(in)e	2	turp(en)t(in)e	2

<sup>a</sup> Parentheses indicate the use of a braille contraction for the letters or word enclosed

<sup>b</sup> Sessions were selected to highlight specific spelling responses

incorporated into his responses (e.g., spelling kerchief with a *k*), even if he still did not spell the word correctly.

## **Results for Helen**

**Definition recall.** Helen learned the definitions of 18 words over 41 sessions and maintained learning at 100%. Figure 3 provides Helen's percentage of correct definitions recalled (scores of 2). Session 4 was the first instructional session, and the probe in Session 5 shows an immediate increase in correct responses for the auditory condition. Helen reached mastery criterion during Session 21 for the auditory condition and during Session 27 for the flashcard condition. When the auditory strategy was used to teach the control set of words during a best alone condition, there was not an immediate increase in correct responses, but she did show an increase in correct responses during the second probe, and she reached mastery criterion during Session 44. Visual analysis shows low, stable performance for both strategies in baseline with an immediate change in level and acceleration toward criterion for the auditory condition. There is little difference between the acceleration of the two strategies, and a clear pattern of differentiation does not occur, even though it takes fewer sessions to mastery in the auditory condition. However, visual analysis also shows that both strategies are effective when compared to a control set of words.

Helen was able to maintain her definition recall regardless of the strategy used, though she had several sessions that fell below 100% correct responding for flashcard and auditory sets during the best alone condition. Additionally, Helen was able to generalize her definition recall to an unfamiliar person during circumstances different than intervention.

**Spelling.** Figure 4 provides Helen's percentage of correct spellings (scores of 2). At the start of the first instructional session Helen was able to correctly spell one word from each word

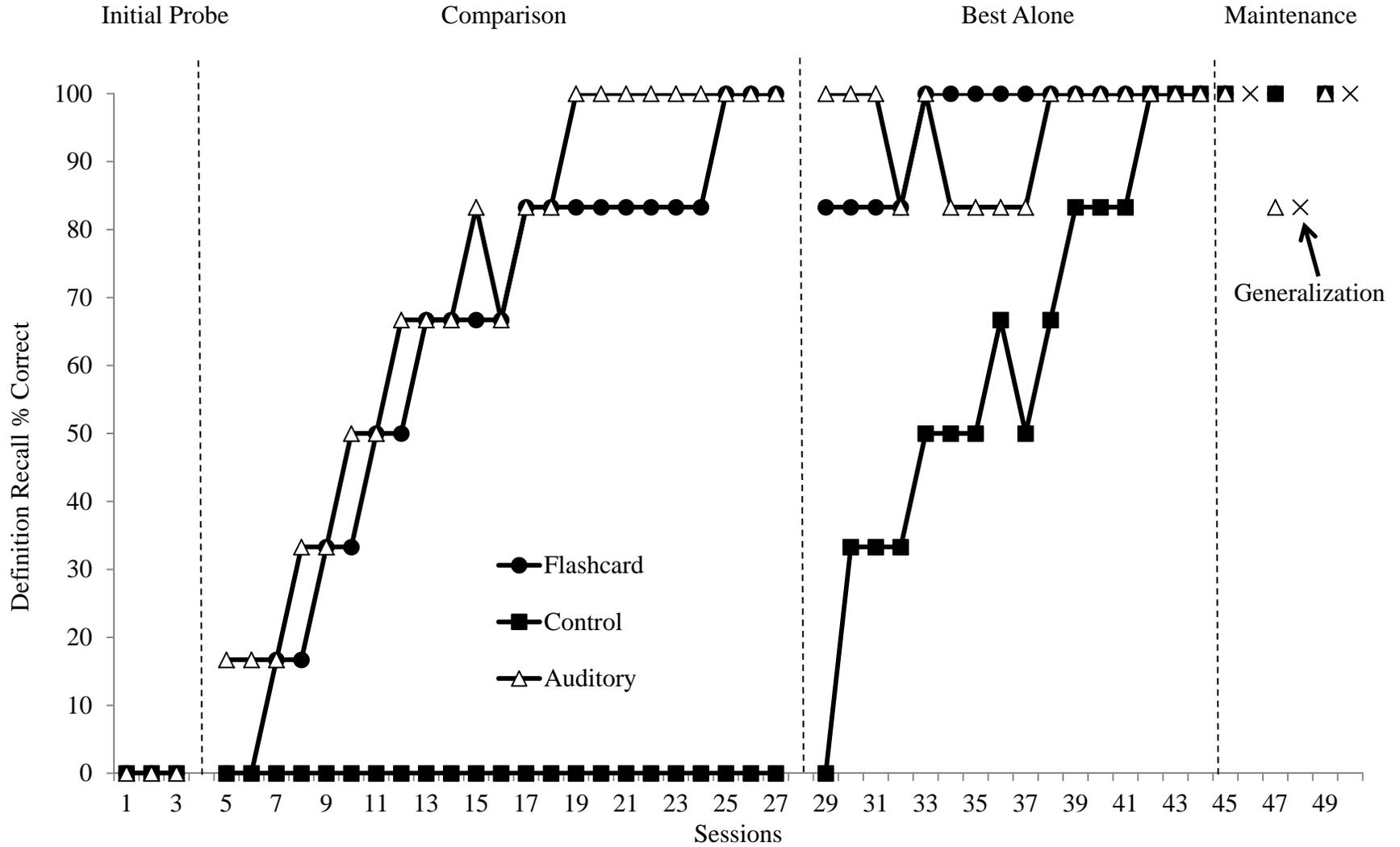


Figure 3. Percentage of target word definitions recalled correctly (score of 2) for Helen.

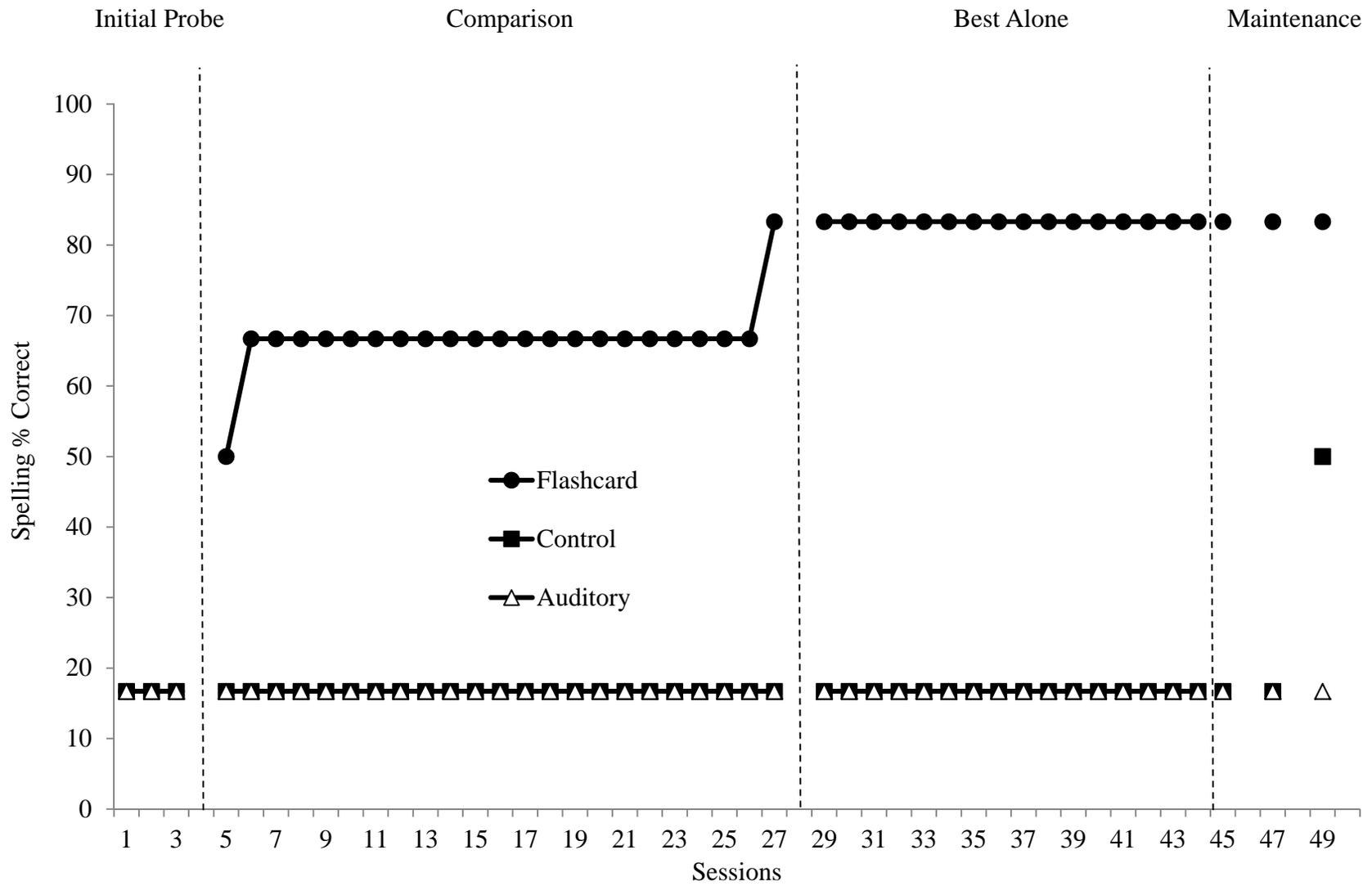


Figure 4. Percentage of target words spelled correctly (score of 2) for Helen.

Table 9

*Spelling Responses from Select Sessions for Helen*

Word Set	Correctly Spelled Words <sup>a</sup>	Spelling and Score for Select Sessions <sup>b</sup>							
		Session 3		Session 5		Session 16		Session 29	
Flashcard	c(en)t(en)nial	s(en)t(in)ial	0	c(en)t(en)nial	2	c(en)t(en)nial	2	c(en)t(en)nial	2
	punctual	punctual	2	punctual	2	punctual	2	punctual	2
	bram(ble)	bramble	1	bramble	1	bramble	1	bram(ble)	2
	defi(ance)	defi(en)ce	0	x <sup>c</sup>	0	defiance	1	defiance	1
	a(sh)(en)	ation	0	a(sh)(en)	2	a(sh)(en)	2	a(sh)(en)	2
	mack(er)el	maccural	0	maccural	0	mack(er)el	2	mack(er)el	2
Auditory	indol(ence)	(in)del(en)ce	0	x <sup>c</sup>	0	(in)del(en)ce	0	(in)del(en)ce	0
	(con)jug(ation)	conagation	0	x <sup>c</sup>	0	congagation	0	congagation	0
	rancid	ransid	0	ransid	0	ransid	0	ransid	0
	(ch)loride	cloride	0	cloride	0	cloride	0	cloride	0
	mosque	mosk	0	mosk	0	mosk	0	mosk	0
	(sh)ill(ing)	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2
Control	p(er)suasive	p(er)swasive	0	p(er)swasive	0	p(er)swasive	0	p(er)swasive	0
	wra(th)	raff	0	raff	0	raff	0	raff	0
	fraternal	freturnal	0	freturnal	0	freturnal	0	freturnal	0
	fissure	fiz(er)	0	fiz(er)	0	fiz(er)	0	fiz(er)	0
	imm(en)s(ity)	im(en)tity	0	im(en)city	0	em(en)city	0	em(en)city	0
	twe(ed)	twe(ed)	2	twe(ed)	2	twe(ed)	2	twe(ed)	2

<sup>a</sup> Parentheses indicate the use of a braille contraction for the letters or word enclosed

<sup>b</sup> Sessions were selected to highlight specific spelling responses

<sup>c</sup> Helen indicated that she did not know how to spell these words and provided no written response

set (see Table 9). After repeated exposure to braille for the 6 words in the flashcard condition,

Helen increased and maintained correct spellings for those words. She did not learn the correct spellings for words in the auditory set or the control set. Table 9 shows a selection of Helen's spelling responses during each phase. Visual analysis shows a change in acceleration toward criterion only for words in the flashcard condition.

### **Results for Vincent**

**Definition recall.** Vincent learned the definitions of 18 words over 17 sessions and maintained learning at 100%. Figure 5 provides Vincent's percentage of correct definitions recalled (scores of 2). Session 4 was the first instructional session, and the probe in Session 5 showed an immediate increase in correct responses for all three word set conditions. Vincent reached mastery criterion during Session 11 for the auditory condition, and during Session 13 for the flashcard condition. When the auditory strategy was used to teach the control set of words during a best alone condition, there was not an immediate increase in correct responses, but he did show an increase in correct responses during the second probe, and he reached mastery criterion during Session 20. Visual analysis shows low, stable performance for both strategies in baseline with an immediate change in level and acceleration toward criterion. While there is overlap during Session 8, the preceding three data points as well as the following two show a clear differentiation between the auditory condition and the flashcard condition.

Vincent was able to maintain his definition recall regardless of the strategy used as evidenced by continued 100% correct responding for flashcard and auditory sets during the best alone condition, and 100% correct responding for all 3 words sets during maintenance.

Additionally, Vincent was able to generalize his definition recall to an unfamiliar person during circumstances different than intervention.

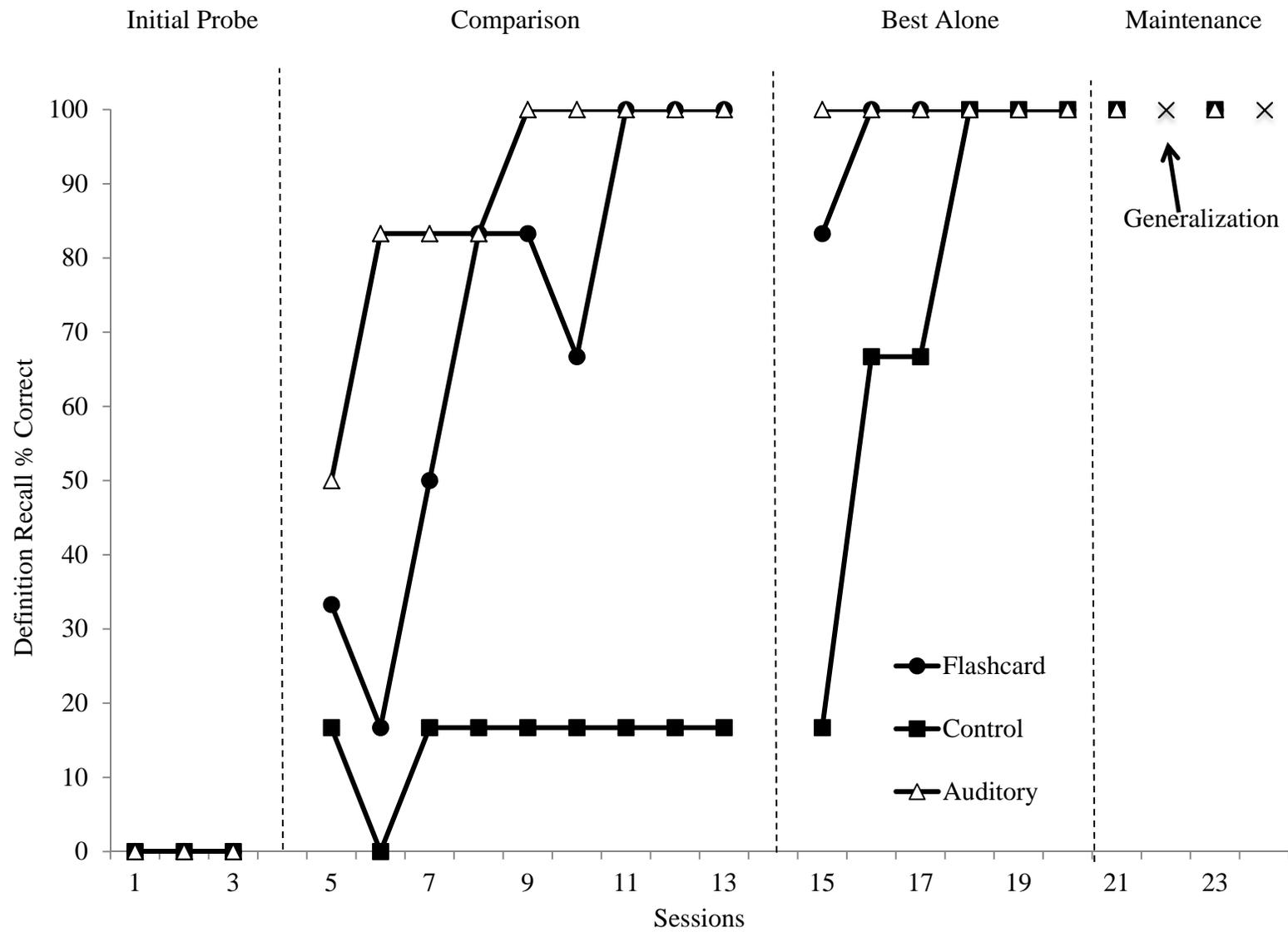


Figure 5. Percentage of target word definitions recalled correctly (score of 2) for Vincent.

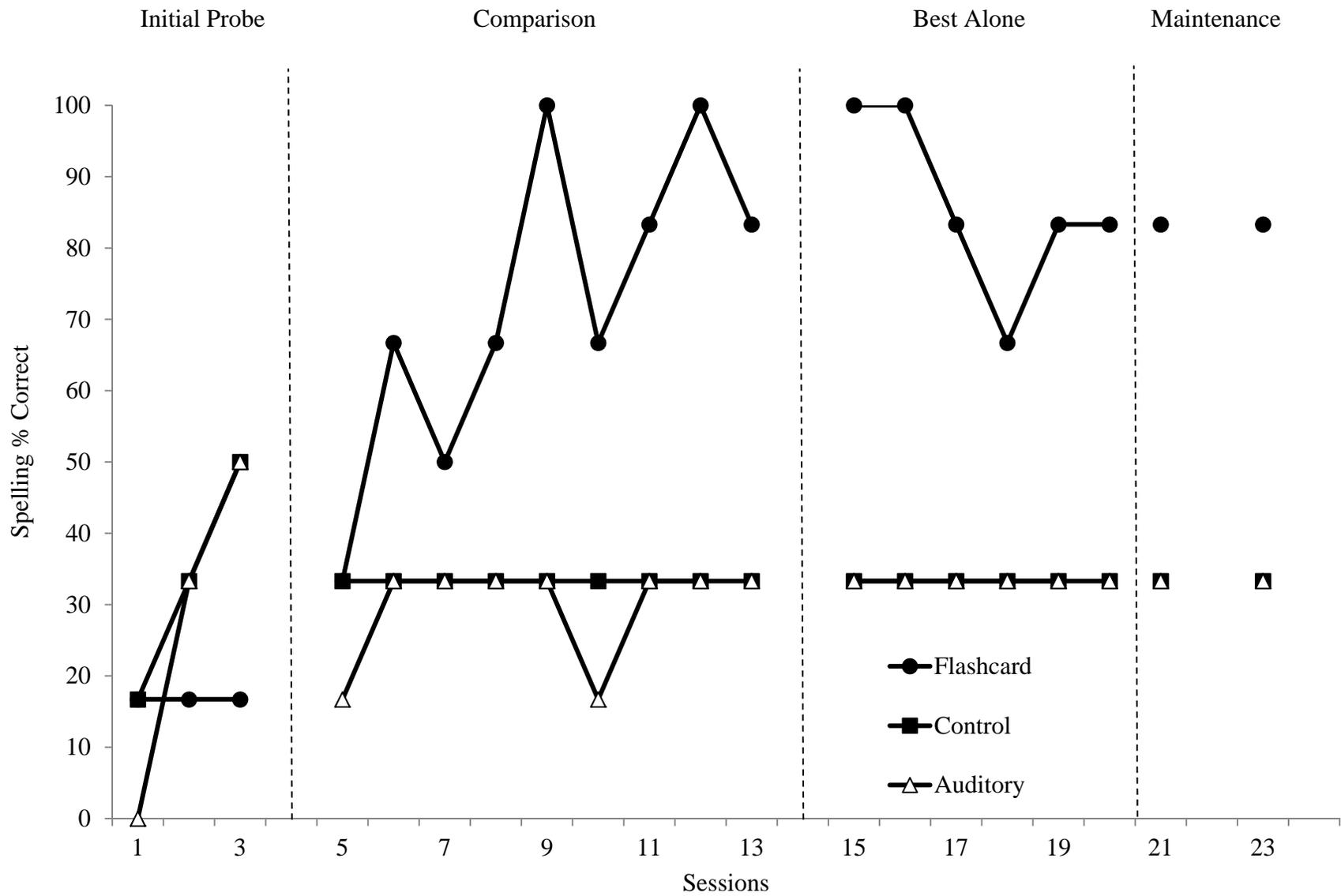


Figure 6. Percentage of target words spelled correctly (score of 2) for Vincent.

Table 10

*Spelling Responses from Select Sessions for Vincent*

Word Set	Correctly Spelled Words <sup>a</sup>	Spelling and Score for Select Sessions <sup>b</sup>							
		Session 2		Session 8		Session 16		Session 21	
Flashcard	brawl	brall	0	brawl	2	brawl	2	brawl	2
	frantic	frantick	0	frantic	2	frantic	2	frantic	2
	frail	frail	2	frail	2	frail	2	frail	2
	c(en)t(en)nial	x <sup>c</sup>	0	c(en)t(en)nial	2	c(en)t(en)nial	2	c(en)t(en)nial	2
	div(er)s(ity)	x <sup>c</sup>	0	dev(er)s(ity)	0	div(er)s(ity)	2	div(er)s(ity)	2
	a(sh)(en)	x <sup>c</sup>	0	a(sh)(in)	0	a(sh)(en)	2	a(sh)(in)	0
Auditory	c(ar)avan	c(ar)ravan	0	c(ar)ivan	0	c(ar)ivan	0	c(ar)rivan	0
	bram(ble)	bram(ble)	2	bram(ble)	2	bram(ble)	2	bram(ble)	2
	imm(en)se	x <sup>c</sup>	0	(en)m(ence)	0	(en)m(ence)	0	(en)m(ence)	0
	defi(ance)	x <sup>c</sup>	0	difi(ence)	0	difi(ance)	0	difi(ence)	0
	deface	deface	2	deface	2	deface	2	deface	2
	wra(th)	ra(th)	0	ra(th)	0	ra(th)	0	ra(th)	0
Control	relia(ble)	x <sup>c</sup>	0	reli(ble)	0	reli(ble)	0	reli(ble)	0
	(sh)ill(ing)	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2	(sh)ill(ing)	2
	dual	dule	0	dule	0	dule	0	dule	0
	p(er)suasive	x <sup>c</sup>	0	x <sup>c</sup>	0	p(er)swaiscwife	0	x <sup>c</sup>	0
	spr(in)t	spr(in)t	2	spr(in)t	2	spr(in)t	2	spr(in)t	2
	rancid	ranc(ed)	0	ranc(ed)	0	ranc(ed)	0	ranc(ed)	0

<sup>a</sup> Parentheses indicate the use of a braille contraction for the letters or word enclosed

<sup>b</sup> Sessions were selected to highlight specific spelling responses

<sup>c</sup> Vincent indicated that he did not know how to spell these words and provided no written response

**Spelling.** Figure 6 provides Vincent’s percentage of correct spellings (scores of 2). At the start of the first instructional session Vincent was inconsistent in his spelling of words (see Table 10). After repeated exposure to the 6 words in the flashcard condition, Vincent increased correct spellings for those words, but was not able to maintain all the correct spellings. He did not learn the correct spellings for words in the auditory set or the control set. Though variable, visual analysis shows a change in acceleration toward criterion only for words in the flashcard condition.

**Interobserver Agreement and Procedural Fidelity**

IOA data were collected on 37% of sessions for Peter, 39% of sessions for Helen, and 38% of sessions for Vincent. IOA results for each participant in each experimental condition are reported in Table 11.

Table 11

*Average IOA Across Participants and Conditions*

Variable	Average % Agreement								
	Peter			Helen			Vincent		
	P	C	B	P	C	B	P	C	B
Definition Recall	97	100	100	100	100	100	100	100	100
Spelling	100	97.2	98.1	100	98.1	100	100	97.2	97.2

*Note:* P = probe, C = comparison, B = best alone

Procedural fidelity data were collected for 33% of all sessions for Peter, 37% of all sessions for Helen, and 33% of all sessions for Vincent. PF results for each participant in each experimental condition are reported in Table 12.

One procedural step fell below levels of acceptance for Peter during initial probe. During Session 6, which was the first session of instruction for Peter, one of the flashcards was from the initial word set and a new card needed to be brailled with the replacement word from the final

word set. This mistake was identified and corrected before the investigator started working with Peter.

Table 12

*Average PF Across Participants and Conditions*

Procedural Step	Average % Fidelity								
	Peter			Helen			Vincent		
	P	C	B	P	C	B	P	C	B
<b>Occurring Once per Session</b>									
Materials accessible and ready	100	75	100	100	100	100	100	100	100
Student greeted	100	100	100	100	100	100	100	100	100
Session recorded	100	100	100	100	100	100	100	100	100
Scripted directions	100	100	100	100	100	100	100	100	100
Student thanked and dismissed	100	100	100	100	100	100	100	100	100
<b>Occurring/Non-Occurring Multiple Times per Session</b>									
Definition recall probe	100	100	100	100	100	100	100	100	100
Waits for response (5s)	100	100	100	100	100	99.1	100	100	100
Verbal praise	100	100	100	94.4	100	100	86.1	100	100
Spelling probe	100	100	100	100	99.4	100	94.5	100	100
Waits for response (5s)	100	100	100	100	100	100	94.5	100	100
Verbal praise	100	97.2	100	100	98.8	98.2	88.9	95.8	94.4
Flashcard provided	100	100	100	100	100	100	100	100	100
Target word spoken aloud	100	100	100	100	100	100	100	100	100
Waits for response (5s)	100	98.6	100	100	100	100	100	100	100
Verbal praise	100	98.6	98.1	100	99.4	100	100	98.6	100
Definition spoken aloud	100	100	100	100	100	100	100	100	100
Used in a sentence aloud	100	100	100	100	100	100	100	100	100
Waits for response (5s)	100	100	100	100	100	100	100	100	100
Verbal praise	100	100	100	100	99.4	100	100	100	100

*Note:* P = probe, C = comparison, B = best alone

**Social Validity**

Participants' teachers were asked to complete a six-question survey about vocabulary instruction and the procedures used in this study (see Appendix A). Two participants (Peter and Helen) had the same teacher.

Both teachers viewed vocabulary instruction as very important for their students this year and in the future. One teacher wrote, "Students need an understanding of vocabulary to

comprehend what they are reading/learning.” Both teachers saw visible positive effects of the intervention. One teacher wrote that the intervention, “Benefited students comprehension of subject matter.” The other teacher responded, “Students get excited & use the vocab they have learned, when it comes up during the day.” Neither teacher noticed negative effects of the intervention.

In response to whether they would use the intervention strategy to teach vocabulary, there were mixed responses. One teacher responded she would be likely to use the strategy or have a paraprofessional use the strategy, but provided no further explanation. The other teacher responded neither he nor a paraprofessional would be likely to use the strategy, stating, “My school has a specific word learning strategy we must use.”

## CHAPTER IV

### DISCUSSION

This study was designed to compare the number of sessions to mastery of two strategies for teaching the meaning and spelling of vocabulary words to students who read braille. Specifically, it was based on research with print readers showing that associations formed between the spelling, pronunciation, and meaning of a word can facilitate vocabulary instruction. However, the results of this study with braille readers were not consistent with previous findings with students who read print (i.e., Rosenthal & Ehri, 2008).

#### **Definition Recall**

All three participants learned definitions in fewer sessions to mastery in the auditory only condition; however, they did not learn to spell any new words in this condition. It is possible that the sequential, one cell at a time perception of braille may strain orthographic and phonological processing (Adams, 1990), making listening and reading braille simultaneously more taxing to working memory than listening and reading print simultaneously. In effect, it is possible that the flashcard condition required students to split their attention between auditory information provided by the investigator and tactile information on the flashcard. Whereas, students could focus all of their attention on the auditory information provided by the investigator during the auditory only condition. The procedure also appeared to be slower for Helen. Although she was able to reach mastery in both conditions, it took Helen 2.5 times as long as Peter or Vincent to learn the meanings of all 18 words. One possible explanation for this finding was Helen's working memory deficit, as measured by the WISC-IV. Based on WISC-IV scores, both Peter and Vincent had low average working memory, whereas Helen had extremely low working

memory. The result was that Peter and Vincent were able to recall several definitions after the first instructional sessions, and Helen was usually able to recall one new definition per session. Helen began saying, “[word] means...” out loud and waited several seconds to see if the phrase triggered her memory of the definition. This began in Session 33 and had a visible positive effect on her confidence, though she reached mastery in a similar number of sessions.

The learning of definitions maintained at 100% levels for all participants, with some variability for Helen. During the best alone condition, her maintenance of the first two word sets dipped to 83% for several sessions (see Figure 3). The words that were giving her trouble were *centennial* and *conjugation*. There was a period of time between Session 29 and Session 37 where she recalled one or the other. The similarity of these words in length and beginning letter may have contributed to her confusion. However, she was able to correctly recall both words correctly beginning in Session 38. This improved recall may have been due, in part, to the strategy Helen began using during Session 33.

Additionally, Peter and Helen were reported to use words spontaneously in conversations with other people. Peter saw a show put on by a troupe from Montreal, and told them that he knew French. When asked what he knew how to say, Peter shared the word *madame*. He also taught his classmates to refer to the investigator as, “Madame Savaiano.” Helen ran into the investigator’s advisor, and when asked how she was doing, Helen shared that she enjoyed learning the words and shared the meanings for *defiance* and *shilling* with minimal prompting.

## **Spelling**

One reason for collecting spelling data was to answer the question of whether students would learn the correct spellings of words when the flashcard was present (correct spelling defined as using correct braille contractions as necessary). While the auditory only condition

took fewer sessions to mastery for learning definitions, the flashcard condition was more efficient for learning correct spellings. In fact, none of the participants learned to spell any new words in the auditory only condition. Practically speaking, the value of learning the meaning and spelling of a word was evident in the generalization probes, when students spent more time reading words from the auditory and control word sets than words from the flashcard set.

Even though more decoding was necessary to read those words, they were able to pull the correct word from memory. Peter was even able to remember some spelling features from his one time exposure during generalization and apply them to his spellings during maintenance probes (see Table 8). For instance, while he correctly spelled *brawl* and *caravan*, he also corrected the first letters of the word *century* and *kerchief* as well as the final letter in *century*. He eliminated the *w* he had been using to spell *sufferer* and changed the *ai* he had been using to an *e* in the word *peso*. These slight corrections show that even a one-time exposure to the correct spelling of a word has the ability to change an ingrained pattern of spelling.

While all three students were able to learn the correct spelling of some words in the flashcard condition, they did not necessarily learn braille contractions through repeated exposure. As an example, Helen could read the *ble* and *ance* contractions found in the words *bramble* and *defiance*, but she was unable to use the contractions in her writing. This inability to write contractions was evident by her consistent scores of 1 for both words throughout the comparison phase (see Table 9). At one point, Helen's teacher explicitly taught her the *ble* contraction, and she incorporated it into her spelling of the word *bramble* in Session 27. Prior to that, even with daily exposure to the correct spelling in Sessions 5 – 27, she had been unable to spontaneously use the *ble* contraction.

## Limitations

While the pattern of sessions to mastery was evident in all three participants, there are limitations to the generalizability of findings from single-case experimental design. All three participants were middle grade students in a residential school for the blind, in modified academic programs, with a maximum visual acuity of light perception. The results of this study do not reflect students in inclusive settings or students who read braille and have residual vision. These participants were also proficient braille readers, and it is not assured that procedures would be as effective with beginning braille readers. The procedures were effective for teaching the meanings of vocabulary words to students with ADHD, Asperger Syndrome, working memory deficits, and learning disabilities.

Vincent returned to his home district after the winter break, and we were unable to complete the last generalization session and maintenance probe (see Figure 5). However, Vincent's maintenance of 100% in the previous two probes and the best alone condition are good evidence that his learning maintained.

One practical limitation of this study is the equation of definition recall with vocabulary learning. Although definitions are a key part of vocabulary instruction, there was no measure of whether students understood the meanings of the words by the end of the study. It is possible that students memorized the definitions without understanding them. There was anecdotal evidence that Peter and Vincent understood some words from their sets. As mentioned previously, Peter began using the *madame* in conversations. He also correctly extrapolated that in two centuries (*century* being a target word) it would be 2213. Although there were no reports of Vincent using intervention words in other situations, he asked the investigator many questions indicating understanding of the words. Specifically, his reaction to the intervention sentence for *deface* (see

Table 5) was to inhale sharply and declare, “Not!” showing an understanding that the actions described in the sentence were negative. In a similar instance, after the investigator read the sentence for *rancid*, Vincent laughed and said, “Like the milk,” referring to cartons of milk the teacher threw out that morning because they spoiled. Additionally, Vincent expressed interest in the size of a *shilling* on multiple occasions, wondering if it was like a quarter. While these responses are encouraging, Helen did not display similar curiosity or provide any hints to whether she understood the meanings. As such, it is possible that Helen did not increase her understanding of the words.

### **Implications**

To my knowledge this study represents the first intervention research of vocabulary instruction for students who read braille. Additional studies are needed to confirm the findings reported here. While study procedures may take more sessions to mastery for students with below average working memory, it is clear that these procedures are effective for teaching definitions to mastery and, with slight modification, teaching correct spellings. Even though the auditory only condition took fewer sessions to mastery, the difference of two sessions (Peter and Vincent) to mastery may not be instructionally relevant.

Procedures used in this study provided four exposures to each target word during instruction and were constrained to a specific block of time during the school day. In practice, teachers would have more freedom to integrate vocabulary words in activities throughout the day, providing multiple contexts as well as more exposure. It would be possible to include words in writing activities and provide hands on experience with some of the more concrete words. It is possible that in practice, Helen’s teacher would be able to provide enough exposures to words throughout a school day to supplement the explicit vocabulary instruction and make the strategy

more efficient. Similarly, more time was needed to implement the procedure with Vincent. One possible explanation was his ADHD diagnosis. Within the constraints of this study Vincent would tire or get distracted during sessions, requiring breaks and/or redirection. In practice, it would be possible to teach smaller word sets and integrate his words into a variety of shorter activities in a way that would hold his attention.

One teacher stated that he would not be likely to use the strategy because his school had “a specific word learning strategy” he was required to use. This word study time was explicitly for spelling words, and this teacher had been told on one occasion that word study time was not for teaching vocabulary. The normal word study set for this teacher’s class was ten words, and word study time often extended to 45 minutes. This study showed that it is possible to teach the meanings of a set of 12 words in fewer than 15 minutes. It would be possible to use study procedures to teach meanings alongside spellings in a way that would not take extra instructional time. Both teachers reported that vocabulary was important to their students now and for the future; however, vocabulary instruction does not appear to be a priority even though we know there is an association between vocabulary and reading comprehension (Nagy, 2005).

It is possible that a slight adjustment to the procedures for the flashcard condition would take a similar number of sessions to mastery as the auditory only condition. By separating the instruction from the presentation of the flashcard by a few seconds, students may be able to direct all of their attention to the auditory information, then all of their attention to the flashcard. This procedure would potentially be the more effective strategy, because students would be learning definitions and correct spellings at the same time. The effectiveness of this procedure change will be investigated in a follow-up study.

APPENDIX A

SAMPLE DATA COLLECTION FORMS

*Sample Data Collection Form for Peter*

Date:		Participant ID:		
		Observer:		
Word Set	Condition	Word	Definition Recall (0,1,2)	Spelling (0,1,2)
A	Flashcard	madame		
		ashamed		
		rejoice		
		chloride		
		shilling		
		interruption		
B	Auditory	tweed		
		century		
		frantic		
		kerchief		
		sufferer		
		unnatural		
C	Control	peso		
		bravery		
		brawl		
		caravan		
		industrious		
		turpentine		

Total Time:	Comparison	Probe	Best Alone
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*Sample IOA Data Collection Form for Peter*

Date:	Participant ID:		
	Observer:		
Word Set	Word	Definition Recall (0,1,2)	Spelling (0,1,2)
A	madame		
	ashamed		
	rejoice		
	chloride		
	shilling		
	interruption		
B	tweed		
	century		
	frantic		
	kerchief		
	sufferer		
	unnatural		
C	peso		
	bravery		
	brawl		
	caravan		
	industrious		
	turpentine		
	% IOA		

Total Time:	Comparison	Probe	Best Alone
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*Social Validity Questionnaire*

1. How important is vocabulary instruction for your students' future success?
  - a. Very Important
  - b. Somewhat Important
  - c. Not important

Please explain your choice:

2. How important is vocabulary instruction for your students' this year?
  - a. Very Important
  - b. Somewhat Important
  - c. Not important

Please explain your choice:

3. How likely is it that you will use this strategy to teach vocabulary?
  - a. I will definitely use this strategy.
  - b. I am likely to use this strategy.
  - c. I am not likely to use this strategy.
  - d. I know I will not use this strategy.

Please explain your choice:

4. How likely is it that you will have a paraprofessional use this strategy to teach vocabulary?
  - a. I will definitely have a paraprofessional use this strategy.
  - b. I am likely to have a paraprofessional use this strategy.
  - c. I am not likely to have a paraprofessional use this strategy.
  - d. I know I will not have a paraprofessional use this strategy.

Please explain your choice:

5. Are you seeing any visible positive effects that could be due to the intervention?

Yes                      No

If yes, please provide examples:

6. Are you seeing any visible negative effects that could be due to the intervention?

Yes                      No

If yes, please provide examples:

APPENDIX B

INTEROBSERVER TRAINING SCORING DEFINITIONS

## Definition Recall Scoring

### PLEASE USE A DICTIONARY/THESAURUS TO HELP WITH SCORING

1. Look at the vocabulary word. Is the participant's response related to the vocabulary word?
  - a. No = score 0
  - b. Yes = continue
2. Look at the definition. Is the participant's response related to the definition?
  - a. No = score 1
  - b. Yes = see examples below

2	1	0
<ul style="list-style-type: none"><li>• Definition from instruction</li><li>• Good synonym</li><li>• Enough description to convey understanding</li></ul>	<ul style="list-style-type: none"><li>• Partial description (e.g. <i>span of time</i> for century instead of 100 years)</li><li>• Example of the word (e.g. <i>abcd</i> for alphabet)</li><li>• Does not have clear links between thoughts (e.g. <i>hands...time...wall</i> for clock)</li><li>• Vague synonym (e.g. <i>animal</i> for cow)</li><li>• Partial understanding (e.g. <i>where you put animals</i> for kennel)</li></ul>	<ul style="list-style-type: none"><li>• "I don't know"</li><li>• No response</li><li>• Incorrect definition</li><li>• Correct answer followed by incorrect answer</li><li>• If followed by other responses that are not explicitly correct [2], maintain score of 0 (e.g. <i>protects your head...flowers</i> for umbrella)</li><li>• If the word itself is used as the only definition (e.g., <i>full of grace</i> for graceful)</li></ul>

- Synonyms = with the word itself (not necessarily the words in the definition)
  - e.g.: wiggle for squirm (twist and turn) = score of 2
  - e.g.: crazy for frantic (very excited) = score of 1
- If a good synonym is part of the definition along with additional info. that info. needs to be related to receive a score of 2 (e.g. copy for imitate = score of 1 because definition = to copy someone or something)
- If more than one response is provided, and none are incorrect, score the best response (e.g. sod: grass ... *wet grassy ground* – score =2; sod: grass ... *wet ground* – score = 1)
- It is not our job to create the connections for the student... Be as objective as possible

APPENDIX C

GENERALIZATION PASSAGES

## Generalization Passages for Peter

### Nancy Wake

One century ago, Madame Nancy Wake was born. She joined the army, where she wore a tweed uniform. When the war started she was in a big brawl, but she did not hurt many people. When the war ended, she won a medal for her bravery. People today still rejoice when they hear her story.

Number of sentences: 5

Number of words: 55

Number of letters: 219

SMOG Index: 4.8

SMOG Index without underlined words: 3.2

### Jake's Trip

Jake was working one day when there was an interruption. His friends wanted to drive in a caravan to the museum of money. Jake saw a shilling, a lira, and a peso before it was time to go. He did not want to be a cold sufferer so he put a kerchief around his head before he went outside again.

Number of sentences: 4

Number of words: 60

Number of letters: 227

SMOG Index: 5.3

SMOG Index without underlined words: 1.8

### Joe's Job

Joe is an industrious house cleaner. He is not ashamed of his job. When frantic people call him, Joe is happy to help. He uses a lot of unnatural cleaners, like chloride, bleach, and turpentine so he always wears goggles and gloves whenever he is working.

Number of sentences: 4

Number of words: 46

Number of letters: 202

SMOG Index: 6.0

SMOG Index without underlined words: 3.4

## Generalization Passage for Helen

### Out Fishing

Mary and Jeff were fishing when Mary said, “The fish are defiance us!” Jeff laughed and said, “That’s the wrong conjugation. You mean defying.” Just then, a mackerel jumped into the boat and its immensity knocked Mary overboard. Jeff was very fraternal and as he helped her back in he told her not to worry because chloride in the water kept it safe for people.

Number of sentences: 5

Number of words: 67

Number of letters: 284

SMOG Index: 6.5

SMOG Index without underlined words: 3.2

### Late to the Party

Yesterday, Mo and his family were going to a centennial party for their mosque. The party began with a prayer, so it was important to be punctual. Because of Mo’s indolence, he did not want to go. His mom was very persuasive, and Mo finally got ready to go. He could feel his parent’s wrath as they rushed to the party.

Number of sentences: 5

Number of words: 61

Number of letters: 248

SMOG Index: 7.5

SMOG Index without underlined words: 5.4

### Rob’s Bad Day

Rob was walking in his tweed suit when he saw a shilling on the ground. As he went over to get it, he tripped on a fissure in the sidewalk and his suit ripped on a bramble. He used the money to buy some milk, but his face turned ashen because the milk was rancid. Rob was not having a good day.

Number of sentences: 4

Number of words: 62

Number of letters: 248

SMOG Index: 3.4

SMOG Index without underlined words: 3.4

## *Generalization Passages for Vincent*

### The Hockey Game

Dave was persuasive and talked his mom into seeing a hockey game. The arena was immense and they ended up in a caravan to their seats. Two players got into a brawl right away. The coaches looked frantic as they tried to calm everyone down. Dave had dual opinions: he liked the action, but didn't want anyone to get hurt.

Number of sentences: 5

Number of words: 60

Number of letters: 253

SMOG Index: 6.5

SMOG Index without underlined words: 4.8

### Alice's Morning

Alice lived in England, where you could buy a drink for a shilling. There was not a lot of diversity in her town, and most girls her age had ashen faces. One morning, she saw someone deface her fence. She started to sprint after the person, but her pants got caught on a bramble and the person got away.

Number of sentences: 4

Number of words: 59

Number of letters: 237

SMOG Index: 3.4

SMOG Index without underlined words: 1.8

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