CREATIVE TYPESETS REQUIRE INNOVATIVE SOLUTIONS: A STUDY OF DIFFERENCES IN BRAILLE INDICATORS

By

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DEDICATION

This book is dedicated to Malia, who was with me on my first day of college, and who lived long enough to see me ***PH****inishe****D***.

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ABSTRACT

Currently, students who read tactually must learn specific braille indicators that correspond to typeset changes such as bold, italic, and underline. These symbols do not stand out like printed attributes. To learn emphasis indicators, students must understand the concepts of print and memorize corresponding braille coding, which requires explicit training. Because tactile readers can only “see” that which is under his/her fingers, scanning and locating indicators is difficult. One must scan the passage word by word to find the emphasis indicator. In contrast, a sighted child can quickly glance at a page and recognize attributes instantly. The difficulty in tactually recognizing typeset, leads to slower recognition of important information and potentially affects reading fluency for beginning readers.

This research study compared the use of the current braille code (CBC) with two alternate ways of presenting typeset. The research questions were: (a) Is there a difference in ***speed*** in finding the emphasis indicators when presented in three different formats? (b) Is there a difference in ***accuracy*** of recognizing the emphasis indicator when presented in three different formats? (c) What are the students’ perceptions and opinions about the various indicators?

A quasi-experimental design was implemented and three types of data were collected: (a) ***measurement of speed*** - in seconds, (b) ***measurement of accuracy*** – in number of correctly identified words and indicators, and (c) the perceptions of students before and after the data were collected. The independent variables were the three ways

of presenting typeset (CBC, U_a, and U_b), and the dependent variables were speed and accuracy. Quantitative data were analyzed using ANOVA for speed and accuracy and correlational data were conducted to determine if relationships existed between speed and accuracy. Qualitative data were categorized and reported.

Results showed a statistical difference between the speed at which students located words with emphasis, but no difference was found in their accuracy. Interview data showed that most students did not have a grasp of print concepts or understand the purposes of using the indicators. Students also indicated that they preferred the alternate formats (U_a or U_b), rather than the current braille code (CBC).

CHAPTER 1: INTRODUCTION

In a literate society, life without the ability to read and write is difficult to imagine. Reading and writing are essential to everyday tasks such as writing phone numbers, paying the bills, creating grocery lists, and keeping track of daily activities. Literacy tools are used to record and recall information, enabling access of data and acquisition of knowledge.

For people who are blind or visually impaired, braille is a tactile alternative to reading printed text. Learning to read in braille is one approach to literacy. The ability to process information in a written format allows communication to occur expressively and receptively. Reading and writing cannot be replaced by aural skills. Therefore, braille is the preferred literacy medium for people who are blind or visually impaired and who need an alternate medium.

To provide contexts that are congruous with printed text, the braille code must evolve in the same way that printed materials evolve. However, as illustrated in the following pages, certain problems arise in maintaining the integrity of print when it is transcribed into braille. Research conducted for this dissertation was designed to examine various methods of presenting visual information in tactile form. Specifically, the researcher focused on ways to transcribe typeset features such as bold, italic, color, and underline into braille. The research questions were (a) Do differences exist in the speed and/or accuracy of recognizing words of emphasis when they are presented in the current braille code, as compared with either of the two alternate formats proposed for use in this dissertation, and (b) Do the students have a preference for the way in which these indicators are transcribed into braille?

Examination of the English Braille Code

Many tactual systems of writing have been invented. In France, during the late 1700s and early 1800s, raised letters were preferred as a method of tactual reading. Early in the 19th century, Louis Braille, a man who was blind, invented a system of raised dots that he used to pass notes and communicate with his friends. This form of raised dots was what became known as braille. Other experimental codes included *Moon Type*, a system of straight and curved lines; *New York Point*, a code utilizing raised lines and dots invented by William Bell Wait; and *The Fishburne Alphabet*, which consisted of several lines in different angles (Cooper, n.d.). During the early 1900s, using Louis Braille's 6-dot configuration, the British began experimenting with the code by creating additional symbols for frequently used letter combinations and words. These letter combinations and words were called contractions. The *contracted braille* code was appealing to transcribers and readers of braille because the use of contractions reduced the number of pages that were produced and made materials somewhat portable. The contracted system became known as the *Standard English Braille Code*. Debates in the United States over the best tactual code, known as the "War of the Dots (Irwin, 1955)," resulted in the adoption of the Standard English Braille Code and Louis Braille's 6-dot system. The adopted code is still in use today.

The English Braille code includes various configurations of six raised dots arranged in two columns of three dots (see Figure 1.1). Each dot is numbered one through six, and the numbers are used to refer to the arrangement of dots in a Braille cell. For example, we refer to the letter “a” as “dot 1.” Individual configurations of the six dots are called braille cells, of which 64 configurations are possible, including a blank cell. Each letter of the alphabet has a corresponding braille configuration (see Table 1.1).

Figure 1.1 – A single braille cell

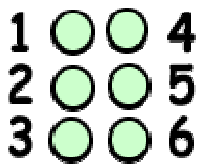


Table 1.1 – English braille alphabet (a darkened dot is the dot that is raised in braille)

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 = ⠵				
1 =⠼⠁	2 =⠼⠃	3 =⠼⠉	4 =⠼⠙	5 =⠼⠑	6 =⠼⠋	7 =⠼⠛	8 =⠼⠓	9 =⠼⠊	0 =⠼⠚

The existing contractions in the Standard English Braille Code represent frequent words (i.e. “and,” “people,” “but”) and word parts (i.e. “ation,” “er,” “ing,”). Contractions can be made of single-cell configurations or two-cell configurations. One hundred eighty nine contractions are regularly recognized in the English Braille Code. Although, Durre (1996) argues “The number of contractions included in the braille code is customarily, but incorrectly, referred to as 189, when there are actually 187 contractions, since *against* and *neither* are concatenations of strings for which contractions exist. If these two were not included in the code as separate contractions, their braille forms would still be the same because against is made up of *again* and *st*, and neither consists of *n* plus *either* Therefore, both their actual and spacesaving value and their total space-saving capacity are always zero, regardless of the frequency with which they appear in a given text." (p.50).

In the Roman alphabet, symbols are comprised of curved, horizontal, vertical and diagonal lines (Millar, 1997). The variability of lines allows for an indefinite combination of shapes and symbols. The formation of print letters is dependent on an identifiable configuration of lines, such that if one forms the letter correctly, proportionate shapes can be viewed as the same letter. Thus, print letters can have significant variation in size, style, and thickness (see Table 1.2). In contrast, braille symbols are configured by using a 6-dot symmetrical configuration that has a standardized three-dimensional shape. The width and length of the cell and the height of the raised dots are unchanging. Millar (1997) provided evidence that if the size of the cell or the height of the dots were changed, then the student was unable to recognize the letters.

Table 1.2 – Variations of print letters

Font Style	Size	Style	Thickness
Times New Roman	12 point font	*Italicized font*	**Bold font**
	18 point font		
Arial	12 point font	*Italicized font*	**Bold font**
	18 point font		
Comic Sans	12 point font	*Italicized font*	**Bold font**
	18 point font		

Variations in handwriting, font styles, typeset, and signatures do not exist in braille, because of the standardized shape and size of the braille cell. Therefore, *composition signs* are used to convey necessary conventions of print, such as capitalization, typeset, color, abbreviations, and letter symbols. The English Braille Code also includes special symbols that represent punctuation marks and a unique symbol that signifies a number (referred to as the number sign). For examples of composition signs see Table 1.3, and for examples of punctuation marks see Table 1.4.

Table 1.3 – Examples of composition signs

Composition signs	Example
Typeset (italics, underline, bold) = ⠨	I <u>can</u> do it! ⠠⠊ ⠨⠉ ⠙ ⠭⠖
Color (blue) = ⠸⠃ before the word and ⠠⠄ after the word	I will not go home. ⠠⠊ ⠺ ⠝ ⠛ ⠸⠃ ⠓⠕⠍⠑⠲ ⠠⠄
Capital letters = ⠠ for a single capitalized letter and ⠠⠠ if the word is written in all capital letters	The mouse is QUICK! ⠠⠮ ⠍⠳⠎⠑ ⠊⠎ ⠠⠠⠟⠅⠖

Table 1.4 – Examples of punctuation symbols

Punctuation symbols	Example
Period = ⠲	I like that fat cat. ⠠⠊ ⠇ ⠞ ⠋⠁⠞ ⠉⠁⠞⠲
Quotation marks = ⠦ for an opening quotation and ⠴ for a closing quotation	“May I have more peas?” ⠦⠠⠍⠁⠽ ⠠⠊ ⠓ ⠍ ⠏⠂⠎⠦⠴
Exclamation mark = ⠖	I can do it! ⠠⠊ ⠉ ⠙ ⠭⠖

In examining the existing 64 combinations of the 6-dot braille cell, one quickly realizes that with 26 letters, 189 contractions, punctuation symbols, and composition signs, multiple uses of the same configuration must be used. I argue that the braille code is too dense, meaning that too many symbolic representations are assigned to the same braille configuration.

The graphic appearance of a braille cell is not the prominent factor that determines what is being represented. Sowell and Sledge (1986) showed that braille symbols are distinguished by the position of the symbol in relation to what is immediately before and after it. The actual print/braille correspondence is dependent on the position of the dots within a braille cell and the position of the braille cell within the text. In other words, one graphic symbol may have multiple representations. One must sort through the various configurations of braille cells and apply rules governing the usage of each symbol to discern what is being represented. For example, the letter “b” is a two-dot configuration in a vertical positioning of one dot on top of the other. This two-dot configuration has 27 possibilities. I call this “the problem with ‘b’” (see Figure 1.2). The reader must determine the symbol based on the position of the dots in relation to the cell, mainly: a) upper or lower part of the cell, b) what comes before the cell, and c) what is immediately following the cell. The problem for print readers would be similar to the letter “b” having 27 different symbolic representations to signal conventions of print.

Figure 1.2 – The problems with “b”

The letter “b” has a two-dot configuration (⠃). The four different placements in which this configuration can be found are: top left, bottom left, top right, and bottom right side of the cell. Depending on the placement of this two dot configuration and what immediately precedes or follows its placement, several possibilities exist, as seen in the chart below:

Top Left Placement: **The letter “b”** **bl** = blind **brl** = braille	**Top Right Placement:** **upon** – if it has a “u” after it **word** – if it has a “w” after it **these** – if it has a “the” sign after it **those** – if it has a “th” sign after it **whose** – if it has a “wh” sign after it
Bottom Left Placement: **Semicolon** if a space follows it **be** – “be” if it has a space before & after **be** – “be” if at the beginning of a word **bb** – “bb” if it is in the middle of a word **because** – if followed by “c” and a space **before** – if followed by “f” and a space **behind** – if followed by “h” and a space **below** – if followed by “l” and a space	**Bottom Right Placement:** **letter symbol** - if followed by a letter and a space **ence** – if it has “e” after it **ong** – if it has “g” after it **ity** – if it has “l” after it **ment** – if it has “t” after it **ness -** if it has “s” after it **tion** – if it has “n” after it

beside – if followed by “s” and a space **between** – if followed by “t” and a space **beyond** – if followed by “y” and a space **belittle** – if followed by “ll” and a space	

As previously mentioned, the 6-dot configuration is limited to 64 combinations. When one considers the contracted braille code and the need for punctuation symbols, numbers, composition signs, and format indicators, one realizes that 64 configurations may not be enough to convey the conventions and complexity of printed text. One can begin to understand why symbols are easily confused.

Influence of Technology on the Braille Code

With the introduction of word processing and computer generated documents, format, font and typeset have become important visual clues for sighted readers. These visual cues serve as predictors of information, and the reader can scan material, selectively choosing information to read in more depth. For example, a sighted person can look at an invitation, outline, research paper, phone book, or grocery list and be able to gather information using a visual channel. Within seconds, generalizations are made based on format. These quick generalizations help to predict the genre and content of the document. The reader can scan the text, eliminating the need to read every word and selecting information to read more deliberately. In contrast, a person who reads braille must read word by word for several words and lines, before gathering similar information. In addition, print readers have immediate visual access to tables, graphs, charts, and maps. Through graphic images authors provide information. Sighted people can shift their vision back and forth between the image and the text. Complications for the braille reader include not being able to predict information from the image, difficulty interpreting the tactual graphics, and an inability to shift attention from the image to the text which would allow for simultaneous processing of information.

The use of computer technology to create textbooks, materials, and media has been advantageous in creating extra visual cues for print readers. Changes made to the appearances of typeset (bold, italic, color and underline) are found in educational textbooks and materials as a method of drawing attention to specific items on a page. Variations include font styles (i.e. Times New Roman, Arial, Verdana), effects to the font (i.e. underline, bold, italics), artfully designed banners, and application of color to the typeset (Horn, 2004). For the purposes of this dissertation, the word *font* will be used to describe the style of the alphabet being used (i.e. Times New Roman, Arial, Verdana) and the term *typeset* will be used to denote enhanced features of a font (i.e. italics, bold, color, and underline). Definitions of terms used in the paper are presented in the glossary located in the appendix (see appendix K).

Because braille has a standardized shape and does not vary in size, font styling and typeset features are not replicable. Visual cues such as bold, font size, font style, italics, and underlining are portrayed by *composition signs*. Such braille symbols precede word or words and denote that the printed text has a typeset change, but the braille word or words do not change in appearance. Given the nature of tactual reading, braille readers have less access to visual cues and images. The use of composition signs is incongruous to changes in font or typeset and format styling. Ultimately, the difficulty in immediately identifying variations can lead to a lack of awareness of key points, thereby potentially affecting speed and comprehension. Without these alerts, the reader must read more deliberately, at a slower pace, and may miss important words, key points, or additional information. The use of composition signs can lead to slower reading rates and cause difficulty in recognizing similar braille symbols.

Thus far, I have provided a brief history of the literary braille code and an examination of the various configurations of the braille cell. In addition to the literary braille code, users of braille often learn Nemeth Braille Code for Mathematics and Science, and some advanced computer users learn North American Standard Code for Information Interchange Braille (known as North American ASCII Braille) or MIT Code for computer programming (Sullivan, 2008). Additional codes exist for music and foreign languages.

All braille codes except ASCII use the same 6-dot configuration to represent print symbols. Because of the limited number of configurations of a 6-dot cell, ASCII and MIT have two added dots to the bottom of the braille cell (Sullivan, 2008). According to Sullivan, the additional dots were originally used in binary computer programming consisting of eight bits, six of which made up the established 6-dot braille cell.

The 8-dot configuration allows for 255 different combinations. The bottom two dots also are used for a cursor on refreshable braille displays. On a refreshable braille display, the virtual cursor allows a blind or visually impaired user to identify the location of the computer's cursor. Educators for the visually impaired, braille users and advocates of braille debate the use of 6 dot configurations versus 8 dot configurations. Because of recent technological advancements, dots 7 and 8 have been added in the computer braille code. One can argue that the fingertips can only perceive 6 dots at a time. Adding two dots would make the braille cell too big and unrecognizable. Yet, adding dots 7 and 8 lengthens the cell and allows for more configurations. Eliminating duplication of the same configuration would reduce the ambiguity of similar symbols.

Need for Change

Several well-supported arguments exist that necessitate changes be made to the braille code. In the last century, technological, scientific, and mathematical advances have been revolutionary, thus affecting printed text materials. New symbols have been added to sustain evolving mathematical and technological advances. As these symbols are added into print the members of Braille Authority of North America (BANA) discuss the new symbols. They create rules and standards for braille transcription of these symbols. Ultimately, they authorize changes to the code. Such changes have been authorized and published as revisions to the code in 1994, 2002, and most recently 2007.

Cranmer and Nemeth (1991) argued, "The four basic codes (literary, Nemeth, Computer Braille, and the braille code for textbook formats and techniques) were developed independently of one another, with the result that there are numerous conflicts among them with regard to symbols and rules." They asserted that print is a "coherent, uniform system of writing," unlike braille. New symbols can be added to the print system without affecting its existing structure. However, because a limited number of configurations exist in Braille, Cranmer and Nemeth's stated that the symbols must be used in an efficient manner and redundancy should be eliminated. They proposed that a "Uniform Braille Code" be developed, combining the four basic codes. They suggested that the design of such a code would consider all possible print symbols represented in different subject areas (i.e. math, science, literature) and be carefully constructed to avoid conflicting or redundant symbols. Ultimately, a Uniform Braille Code would update the current braille codes by incorporating newer symbols and combining several codes.

In 1995, the International Council on English Braille (ICEB) announced the completion of the Unified English Braille code (UEB) (BANA, 2007b). The development of the code is based on symbols used for the English Braille Code, but incorporates needed symbols for mathematics and scientific notation. Although UEB was adopted by ICEB in 2004, BANA's position is to monitor the use and progress of the code, but has not considered its adoption, as of yet.

A second argument for a need for change is that the use of computers has influenced the production of materials through the invention of word processing programs. These word processing programs allow the user to quickly format and adjust the visual appearance of text. A person using a word processing program has the ability to choose from hundreds of font styles and can apply additional variations to the font such as bold, italic, and underline. Research has shown that students have better retention of information when colored reading materials are presented, and that readers prefer materials produced in color (Kirschenbaum, 2006).

As previously stated, the combination of curved, horizontal, diagonal, and vertical lines is indefinite (Millar, 1997) and letters can have considerable variations in height, width and thickness. Conveying the variations of print symbols in braille is nearly impossible. The current braille code contains one symbol that signifies a change in the typeset (underline, bold, or italic), and a handful of symbols that represent changes to the color. Differences in font are not denoted using the current braille code.

The problem with the limiting nature of portraying font styling and typeset is two-fold. First, a person reading in braille is not able to recognize font changes instantly, as is a person who reads print. Second, the braille code is not designed to uphold an infinite number of differences to symbols in the same way as print. The effect is that the braille reader is slower in recognizing font changes. Such typeset features are essential to rapid understanding of printed materials. Finding braille symbols that represent font changes tactually is not a task equivalent to identifying them visually. As a result, students who read in braille may not give the text attention in the manner in which the writer intended when creating the font change. If a student is overlooking important emphasis that an author intended, the student may not develop the same understanding of the text or acquire the same knowledge.

Lastly, for a young reader, graphic similarity is important to decoding. If the graphic configuration of a word is changed, the possibility of decoding the word may be affected. For a beginning braille reader or a struggling reader, adding a composition sign in front of a word can change the graphic appearance of a word, thus affecting its readability. ATIC and BANA contend that consistency with the shape of a word is important in developing readers (ATIC & BANA, 2007). Changes to the current braille code should take into consideration beginning and struggling readers and eliminate symbols that affect the graphic appearance of a word. When and how a teacher introduces composition symbols should be considered carefully for early and struggling readers (ATIC & BANA, 2007).

How Are Changes Made?

In the past, major decisions to adopt braille codes were made by organizations consisting of members who were strong advocates of tactile literacy. Since 1976, the leading authority on maintaining the integrity of the braille code over the course of time has been BANA (BANA, n.d.). BANA has convened on a regular basis to discuss updating each of the braille codes (BANA, n.d.). These updates have impacted the evolution of tactile literacy modes and changes have reflected advances in printed materials.

On BANA's website, the statement of purpose reads, "BANA's purpose is to promote and to facilitate the uses, teaching and production of braille. It publishes rules, interprets and renders opinions pertaining to braille in all existing and future codes (BANA, 2007a)." For a quarter of a century, BANA has published vital documents regarding updates to each of the codes. Members of BANA include key stakeholders in the field of blindness. Members have included representatives from American Foundation for the Blind (AFB), American Printing House for the Blind (APH), Association for Education and Rehabilitation of the Blind and Visually Impaired (AER), American Council for the Blind (ACB), the Canadian National Institute for the Blind (CNIB), National Federation for the Blind (NFB), National Library Services for the Blind and Physically Handicapped (NLS), and several other organizations.

Twelve special technical committees of BANA have been organized to monitor particular aspects of braille. Some of the technical committees are Literary Braille, Mathematics Braille, Music Braille, Computer Braille, Braille Research, and Early Literacy Materials Production. They are charged with specific duties related to monitoring each of the four braille codes and issues related to production, teaching, and formatting of braille.

One committee has been charged with duties pertaining to research. In the past, changes to the code have been debated by strong advocates and users of tactile writing systems. Often times the debate has generated significant modifications to the code or inventions of new codes, as in the case with computer braille. However, many modifications lack scientific evidence showing that the changes may have an effective impact on the braille reader. In Chapter Two, I provide a historical background on the evolution of the braille code, a detailed examination of how changes to the code are made, a review of research that has impacted alterations to tactile writing systems, and a description of each of the stakeholders and agencies involved with making changes to the code.

Purpose, Rationale, and Importance of this Research

This research was sponsored by BANA as part of the Adhoc committee on research. Because new methods of indicating font styling are being considered for proposal to BANA by the Early Literacy Committee, the study was designed to evaluate three different methods of presenting typeset. The purpose of the study was to design a method of presenting features such as bold, italic, underlining, and color such that children who read braille could find changes in the text quickly and describe the textual differences accurately. A secondary purpose was to devise a system that would not interrupt reading fluency or the flow of text. A third purpose of the research was to investigate student perceptions and opinions about the ways in which font style changes were presented.

Because of the difficulties in how the current braille code presents such font descriptors, scanning text and locating typeset is difficult for braille readers of all levels. The difficulty leads to slower recognition of important information. For example, if a task was to list all italicized words from a passage, the child must read through the entire passage in braille to find each italicized word. In contrast, a sighted child can quickly glance at a page and recognize the italicized words instantly. Ultimately, the current braille standards for presenting font changes can hinder a child’s performance when compared to their sighted peers. First, the delay in recognizing font changes affects efficiency. The child will take longer to complete a task. Second, the child must have been introduced to the braille symbols prior to being expected to complete a task. These symbols can affect reading fluency and interrupt the flow of text. Both of these factors can affect a child’s integration into mainstream classrooms and affect a child’s success within the general education curriculum. In the following research I compared the use of the current braille code with two alternate ways of presenting font changes.

This research has important implications for future production of braille textbooks. The Early Literacy Committee of BANA is considering this study as evidence for suggestions on improving methods of transcribing font and typeset indicators in early literacy materials. Evidence provided in this research could impact future development of textbooks and materials. Additionally, the format used for font styling in this study could be adopted by teachers working with children who read in braille. Teachers can use the suggested format to provide instruction on reading materials that contain font indicators. Once children understand the purpose of font indicators and they are able to identify them quickly, then these indicators would provide an important alternative to visual cues that provide instantaneous information, currently not equivocated in the braille code.

CHAPTER 2: LITERATURE REVIEW

Because modern technology has influenced the variability of fonts used in printed materials (i.e. textbooks), the current braille code is insufficient at indicating various typesets and font styles. Results from this study could have an impact on the development of alternative methods of braille to indicate changes in the typeset. The purpose of this study was to consider ways to present typeset that do not interfere with the flow of text or affect reading fluency. Measurements taken were used to evaluate three tactile formats of indicating visible features of text (i.e. bold, italic, underline, colored words). A secondary purpose was to investigate students' perceptions and opinions about print concepts and formatting of typeset.

The following chapter is written to provide relevant background information regarding: a) the history of tactile reading systems, b) the decision making process used to modify tactile codes, c) tactile discrimination and differences between visual and tactile reading methods, and d) influences of modern technology on the production of printed materials compelling the need for change.

History of the Braille Code

The Revolution Behind the Braille Code

Although many people are familiar with the raised dot patterns seen in nearly every public building, few are familiar with the turbulent history that led to its right of entry into the lives of people who are blind or visually impaired. Several hundred years ago, in Europe, during the 17th and 18th centuries, innovative ideas about people with disabilities resulted in promising educational opportunities. Particularly, people who were visually impaired, once thought of as unteachable, were given opportunities to become independent citizens who contributed to the welfare of the majority. This new way of thinking was demonstrated in a book written by the famous philosopher, Diderot. In this book, Diderot documented examples of how a person may accommodate to the loss of the visual sense. In one of these examples, Diderot presented a man who was blind who taught his son to read using raised letters. He argued that people who were visually impaired could be educated (Lorimer, 1996).

The renaissance era impacted how the general public felt about people who were blind. One noteworthy man, Valentin Haüy, was influenced by the writings of Diderot. He dedicated the majority of his life educating people who were visually impaired (Lorimer, 1996). The educated man, once a translator for King Louis XVI, opened the first school for pupils who were blind in 1784 (Kimbrough, n.d.). In this school, Haüy used wooden letters to teach reading. Later, Haüy invented a method of using casts of iron letters to emboss text using multiple layers of paper. This invention was used to create the first teaching materials for literacy (The Shoder Education Foundation, Inc, 1996-2000).

Haüy's dedication to his pupils and his genuine concern for improving the quality of life for people who were visually impaired became known in France, and his little school, *L'Institut Royal Des Jeunes Avuegles,* soon grew to have nearly 50 pupils. For 18 years, Haüy continued to teach students the core academic subjects that all children in schools learned: reading, writing, and mathematics. Additionally, Haüy's students learned to play music and occasionally performed in concerts to raise money for the school. However, during the later part of the 1700s the political strife of the French revolution in combination with Haüy's political alignment with to King Louis XVI forced Haüy to flee France (Kimbrough, n.d.; Lorimer, 1996). During the revolution, Haüy's brother Réne-Just, a famous scientist and scholar, was executed by revolutionists (Kimbrough, n.d.).

Haüy traveled through Europe with one of his students, Alexandre Fournier. As he traveled, his ideas and methods of teaching people who were blind spread through Europe. Several schools for the blind were initiated, including one in Russia where Haüy remained exiled until 1821 (Lorimer, 1996). During this same time period, in 1791, Edward Rushton founded the Royal School for the Blind in Great Britain.

At *L'Institut Royal Des Jeunes Aveugles*, upon Haüy's departure, Napoleon appointed Sébastien Guillié to be the new headmaster. Life at the school under Guillié's direction was grim. He considered the students to be pitiful degradable creatures. In between some academic lessons, the children were forced to work long hours producing goods (such as hospital sheets, slippers, and nets for fishing) that were sold to provide funding for the school. Living conditions were also bleak. The children's dormitory was 500 years old and concurrently served as a prison for former allies to Louis XIV. Ironically, Haüy's brother was one of the inmates executed in the building that would serve to house one of the most influential pupils of *L'Institut Royal Des Jeunes Aveugles,* Louis Braille (Kimbrough, n.d.).

In 1819, under these austere conditions and the direction of Guillié, Louis Braille became a student at *L'Institut Royal Des Jeunes Aveugles.* Braille, ten years old at the time, adjusted to the conditions and lifestyle at the school. At the school, Braille learned to read using Haüy's embossed textbooks. He also learned to play the organ, a talent that would afford him a few luxuries later in life. The miserable tenure of Guillié lasted until 1821, when he was fired. André Pignier was Guillié's successor (Kimbrough, n.d.; Lorimer, 1996).

Pignier made many changes to the school, including reviving Haüy's philosophy of improving the quality of life for children who were visually impaired by teaching them skills that would allow them to be independent. Pignier invited Haüy for a visit, perhaps one in which Louis Braille and Haüy may have encountered one another. A year later, in 1822, Braille attended Haüy's funeral (Kimbrough, n.d.).

In 1823, a man named Charles Barbier visited *L'Institut Royal Des Jeunes Aveugles.* This visit proved to be the most influential in young Louis Braille's life. Braille, 14 at the time, listened to Barbier as he presented his invention of a code that could be read in the dark. Barbier, a military officer, invented the system of night reading that would not be decipherable to the enemy and could be used during battle. In this system, he used raised puncture marks, arranged in a grid of dots 6x2 (two columns of 6 dots). Barbier assigned dot combinations to specific phonetic sounds used in the French language. Unfortunately, Barbier's code was not appealing to military leaders. However, members of the L'Académie Royale des Sciences were intrigued by the code. They researched its uses and recommended that the tactile system be used to teach children who were blind to read. Louis Braille quickly learned Barbier's system and employed the system for reading and writing (Kimbrough, n.d.).

While Barbier's code had tremendous potential for tactile reading, it had several limitations. First, because Barbier's code used symbols representing phonetic sounds, the spelling of words was based on the writer's best representation of the sounds in a word. The use of the phonetic system resulted in unreliable orthographic representation of words. Additionally, Barbier's code lacked symbols for punctuation and numbers. Lastly, because of the 6x2 configuration of dots, symbols were larger than the finger pad, requiring the reader to use a vertical, up and down, motion to feel the entire configuration. The use of numerous dots made the letters tactually unrecognizable (Lorimer, 1996).

Using Barbier's system of dots, Louis Braille improved upon the code by creating symbols that represented letters of the alphabet in a 3x2 dot matrix. By reducing the size of the configuration, each letter was able to be passed under the finger pad with a sweeping left to right motion, thereby eliminating the inefficient vertical motion that was required to read Barbier's 6x2 dot cell. Additionally, Braille designed the code to include a symbol for each letter of the alphabet (used for spelling), vowels with accent marks, numbers, and punctuation (Lorimer, 1996).

Louis Braille published the first version of the code in 1829 by dictating it to Pignier (Kimbrough, n.d.). The code, in this publishing, had combinations of dots and parallel lines. A ruler, similar to the modern slate and stylus, was used to write the symbols. The device had three slots of parallel lines that a student could punch onto a piece of foil, in reverse from right to left. When the paper was flipped over, it would reveal the embossed text. The code, at the time of this publication, had been tested by pupils of *L'Institut Royal Des Jeunes Aveugles.* The code was designed by a tactile reader and informally tested by students who read using tactile methods – a fact that later became important as debates over the best means for tactile reading ensued (Lorimer, 1996).

In a revised publication in 1837 Louis Braille described the system behind the design of the code (Lorimer, 1996). Using a 6-dot matrix of 2x3 (⠿), he assigned a four dot pattern located in the top portion of the braille cell to the first ten letters (line 1 = a through j) of the alphabet. The next ten letters (line 2 = k through t) used the same configuration of the upper portion of the cell with the addition of one dot in the lower left corner (dot 3). The last five letters (line 3 = u, v, x, y, z) of the alphabet repeated the upper cell patterns and added two lower dots (dots 3, 6), with the exception of the letter w which did not exist in the French language. Additionally, the French language had several accent marks for each of the vowels, which were assigned the remaining configurations of the line 3 (ç, é, á, è, ù). Line 4 mimicked the upper cell pattern and added dot 6. Each symbol on line 4 represented accented vowels (â, ê, î, ô, û, ë, ï, ü, œ, w). Also, the first line of the braille code was used to denote the numerals 1-9 and 0; to prevent confusion between numbers and letters, the number symbol was placed immediately before a number.

Although Braille's tactile code was well received by the students and Pignier at *L'Institut Royal Des Jeunes Aveugles,* the feelings of the instructors were contemptuous. First of all, they resented having to learn a code that did not have a visual resemblance of the Roman alphabet. Secondly, they felt that the current method of using Haüy's embossed letters was a sufficient method for reading. In 1840, Armad Dufau, a new director at *L'Institut Royal Des Jeunes Aveugles*, strongly felt that Braille's code was unnecessary. He banned the use of the code. Dufau instated a British tactile reading code in its place. Alston Type, Dufau's preferred writing system, consisted of raised block letters similar to Haüy's original letters. The students struggled to discern the lower and upper case letters tactually (Kimbrough, n.d.).

In an effort to banish the braille system, shortly after Dufau became director, he ordered that all of the books using the 6-dot system be burned (Kimbrough, n.d.). Severe physical punishment was used if students were found in possession of or seen using the braille system. Despite Dufau's efforts to ban the code, students continued to use the braille system. Eventually, in 1843, Dufau conceded and reinstated the braille system of writing.

Louis Braille died of tuberculosis nearly ten years later, in 1852. Shortly afterwards, in 1854, France adopted Louis Braille's system of writing as the official writing system for people who are blind and/or visually impaired (Kimbrough, n.d.). Then, in 1858, Switzerland also officially adopted the braille system (Lorimer, 1996).

Calling all Contestants: Which Tactile Code is Superior?

As mentioned briefly, Great Britain opened its first school for the bind in 1791. Over the next several decades, several schools were founded, and many tactile writing systems were developed throughout Europe. Among the most popular were the Moon Type (invented by Dr. William Moon, 1845), Alston Type (invented by John Alston, 1830s), Lucas (Thomas Lucas, 1838), and Gall Type (invented by James Gall, 1834)

(Copper, n.d.). Often, the inventors of the codes were not the users of tactile writing systems. Likewise, the decision makers who chose the code were not readers of tactile systems. Communication among people who used the tactile systems was dependent on readability of several dissimilar systems of writing, meaning that tactile readers often learned several letter symbols for literacy (Lorimer, 1996).

In 1832, Great Britain's Royal Scottish Society for the Arts announced that a competition would take place to determine the best reading method for people who were blind (Lorimer, 1996). Judges of this competition, who probably did not use the tactile system of reading, deemed that the winning system, the Fry system, was superior because it closely resembled Roman letters and didn't require that teachers learn a new code (Perkins School for the Blind History Museum, 2004). Despite the results of the contest, tactile readers preferred the dot system over the Roman letters. Roman letters presented undistinguishable lines and curves, in combination with the use of lower and upper case letters, configurations of which were confusing.

After decades of irresolution, one man who was visually impaired, Thomas Rhodes Armitage, decided that a unified tactile system of reading and writing was needed (Lorimer, 1996). In 1869, he gathered several people to research the readability of tactile reading systems. The committee, called the *British and Foreign Blind Association for Promoting the Education and Employment of the Blind* consisted of readers and writers of tactile codes, all of whom were visually impaired. For two years, the committee conducted research with tactile readers as participants. In their studies, they used criteria related to usability including a) legibility by touch, b) size of character under the fingertip, c) consistency with spelling patterns d) shortened notation, and e) similarity to Roman letters (Armitage, 1870, as cited by Kimbrough, undated website). This committee would make the first recommendation related to the use of tactile reading systems based on *scientific research-based evidence*. In 1871, Great Britain adopted the 6-dot braille code, based on the committee's recommendations and their research report.

Tactile Codes in the US

The United States was faced with similar circumstances of having to contend with multiple forms of tactile writing systems. However, in the U.S., the decision about which was the best alphabet to use did not happen until 1932. The history of this decision is detailed in John Irwin's book, *War of the Dots* (1955). A summary of the history is written below.

After an inspiring visit to France's *L'Institut Royal Des Jeunes Aveugles*, Dr. John Dix Fisher began seeking financial support that would enable him to open a similar school in the United States (Perkins School for the Blind, 2005; American Printing House (APH), n.d.). He was able to convince several of Boston's wealthiest men to contribute to the new school, and in 1829 the New England Asylum for the Blind was founded. With the establishment of the institution, Fisher needed to find the right man to direct the new establishment. Two years later, Fisher was reunited with an acquaintance from medical school, Dr. Samuel Gridley Howe, whom he quickly recruited to be the director. To understand what would be needed for this new school, Dr. Howe visited European schools for the blind. Upon returning to the United States and eager to employ the array of techniques he learned from European schools, Dr. Howe set out to recruit students. In 1932 Dr. Howe opened the doors of his father's house to his first six students.

Of the many strategies that Dr. Howe brought to the United States was the use of embossed Roman letters to teach reading. The embossed letters that Dr. Howe used were similar to Haüy's letters. In 1835, Howe simplified the code and invented the Boston Line Type, which was officially adopted at Perkins and used until 1908 (APH, n.d.; NYISE, 2006; Cooper, n.d.).

In 1860, Dr. Simon Pollak from the Missouri School for the Blind visited Paris and witnessed several students using the 6-dot braille method of reading. Upon his return to the U.S., he established the braille code as the official code to be used in the Missouri School for the Blind. That same year, the superintendent of the New York Institute for the Blind, William Bell Wait, tried to convince leaders of the schools in Boston and Philadelphia to adopt the braille code. He was not successful in convincing his colleagues that the braille code was superior. As a result, he created his own system which later became known as New York Point (NYISE, 2006).

Some years later, in 1878, a man by the name of Joel Smith began to modify the existing 6-dot braille system. He created contractions that replaced combined common letter combinations and frequently used words. The contractions were a space saving technique to shorten the length of books. His code became known as Modified American Braille Code (Irwin, 1955).

During the 1830s to1870s the three forms of tactile communication were being used in the U.S., Boston Line Type, New York Point, and the Modified American Braille

Code. The three systems were vastly different from one another and blind readers had to learn all three forms of written code to access printed books and to communicate with one another. In an attempt to create solidarity, the American Association of Instructors for the Blind (AAIB), an association founded by Wait, adopted New York Point as the official code to be used in literary instruction. However, in the 1892 meeting of AAIB this decision was revisited and 6 of the 7 superintendents of schools for the blind voted to adopt the American Modified Braille Code (Irwin, 1955).

The disagreement between the two groups was problematic for a couple of reasons, including difficulties in written communication. However, a larger drawback of having two systems was that instructional materials being produced for the children at these schools had to be produced in two formats, the process of which was costly. Additionally, neither code was being used in any other countries except the U.S. and Canada. The 1886 British adoption of Grade 2 braille, consisting of contractions that reduced the number of volumes books required and sped up reading rates became more popular in the U.S. thus resulting in a growing number of supporters for the British braille code. Avid readers had to learn to read the Standard English Braille Code, being used in Great Britain, as a third tactile system. Debates over the best tactile system continued through the end of the 19th century (Irwin, 1955).

Finally, in 1901, the American Blind People's Higher Education and General Improvement Association wrote a resolution in which the authors detailed plans for forming a committee, called the Uniform Type Committee (UTC) that would conduct research and provide evidence for the best tactile code. This was be the first attempt in the U.S. to use scientific-based research in the decision making process. A five person committee convened consisting of people who were visually impaired and who used the tactile code. Members of the committee were two proponents of New York Point, two proponents of Modified American Braille, and a fifth person in favor of the British braille code. The under-funded research project began by devising a legibility test and testing a small sample of readers. The results of the study were clearly in favor of the Modified American Braille code. The evidence was so overwhelmingly convincing that the two New York Point proponents became supporters of the Modified American Braille code (Irwin, 1955).

When the results of the study were presented in 1909 and members of AAIB learned that the supporters of New York Point no longer subscribed to their point of view, the committee's report was determined to be invalid. Supporters of New York Point argued that the biases of the researchers resulted in unreliable and invalid results. Thus, the findings of the report were not accepted. Five more members were added to the UTC and further research was conducted. Four of the five new members were supporters of New York Point. During this same year, New York Public Schools adopted the Modified American Braille code as the official code for children who were blind. The decision was a disappointing defeat to Wait (Irwin, 1955).

The newly formed UTC began the project by raising money to support a national study. A little over five thousand dollars was raised to begin the research. The committee hired two researchers to travel about the country and to collect data regarding the readability of three different codes: New York Point, Modified American Braille, and

British Grade 2 braille. With a sample of 1200 readers of tactile systems in 36 different states, the researchers were able to test the speed, accuracy, legibility, and space saving ability of the code. In 1911, the UTC presented the results. Findings showed that neither of the two codes being used in the U.S. was better. Rather, the British braille code proved to be superior to both codes. Unwilling to discontinue the existing systems and unsatisfied with the British braille code, the Americans decided to create yet another code. Using the British braille code as a base, punctuation marks, numbers, and contractions were rewritten. The UTC's code was revealed and adopted in 1915 at a conference for the American Association of Workers for the Blind. However, members of the AAIB felt that the issue of having two distinct codes for the English language, British and the newly created American braille, was not an acceptable answer to the existing problems. Therefore, they conditionally accepted the American braille code in hopes that Great Britain would see the advantages of the American system and likewise adopt it (Irwin, 1955).

The political debate between proponents of the British and American system of braille lasted 20 years. Finally, in 1932 Great Britain and the United States agreed upon a unified English Braille Code. The agreement became known as the Treaty of London, named after the meeting that took place in London. Additional changes were made following the Treaty of London. Although these changes were not significant changes to the code, they did result in variations to the rules between the U.S. version and Great Britain's English Braille Code. The current code used today is called the English Braille, American Edition of 1994 (BANA, 1994), which was most recently updated in 2007 (BANA, 2007).

Modifications to the Current Braille Code

As languages evolved and technology influenced printed materials, modifications to the braille code were necessary. The UTC committee responsible for monitoring changes to the braille code underwent restructuring over the years as various organizations gained political clout. In 1976, several organizations joined together to form a body of experts who could preside over the evolution of the braille code. This organization became known as the Braille Authority of North America (BANA). It consisted of representatives from the AAWB, AAIB (which was renamed Association for the Education of the Visually Handicapped, AEVH), American Foundation for the Blind (AFB), National Braille Association (NBA), American Printing House for the Blind (APH), National Federation of the Blind (NFB), and the National Library Service for the Blind and Physically Handicapped (NLS), the Canadian National Institute for the Blind (CNIB), and the Association for Computing Machinery (ACM).

BANA currently consists of representatives from 14 different organizations (BANA, 2007a). They are (a) American Council of the Blind, (b) American Foundation for the Blind, (c) American Printing House for the Blind, (d) Associated Services for the Blind, (d) Association for Education and Rehabilitation of the Blind and Visually Impaired, (e) Braille Institute of America, (f) California Transcribers and Educators of the Visually Handicapped, (g) Canadian Association of Educational Resource Centers for Alternate Format Materials, (h) Canadian National Institute for the Blind, (i) The

Clovernook Center for the Blind and Visually Impaired, (j) National Braille Press, (k) National Library Service for the Blind and Physically Handicapped, (l) National Braille Association, (m) National Federation of the Blind, and (n) Royal New Zealand Foundation of the Blind (Associate Member). In a collaborative effort, these organizations publish rules. They also evaluate recommended changes and issue opinions or interpretations. Their primary purpose is to promote and facilitate the "uses, teaching, and production of braille." (BANA, n.d.).

Organizations such as the American Printing House, National Library Services for the Blind and Physically Handicapped, and other materials production agencies have considerable interest in modifications that are made to the braille code. In particular, APH is responsible for providing educational materials to school systems across the United States. Their current materials include braille and large print publications of textbooks, among other educational tools. Modifications to the code affect the production of these materials. Potentially if significant changes are made, materials need to be recreated.

Educators of the visually impaired also are impacted by changes in the braille code. Major changes would result in teachers needing retraining on the rules code. Additionally, teachers would be affected by a possible delay in materials production. Thus affecting the students they serve.

Ultimately, readers of the braille code are most affected by modifications. The delay in the production of materials coupled with having to relearn symbols and rules have challenging consequences. Yet, if changes were not made, then the code would not evolve with the current influences of technology. Thus, changes to the braille code are necessary. Although they are the subject of heated debates, ultimately the deliberation leads to an enhanced literacy medium for people using tactile means.

Understanding Tactile Discrimination

Major Differences between Print and Braille

First and foremost is the obvious difference: print is visual and braille is tactual. Therefore, the mode of input is different. A sighted person reading in print is able to use vision to fixate on words. Each fixation creates a window to view text (Carreiras & Alvarez, 1999). Due to the nature of tactual reading, a braille reader is limited to the information under his/her fingertips. Braille readers use the tiny pads of their fingertips to identify each braille cell, one at a time, while sweeping across multiple cells with a left to right, hand movement. When comparing the difference between print reading and braille reading, I like to use the analogy of reading through a straw. Troxell (1967 as cited in Foulke, 1979) illustrated the analogy in a study. Readers were asked to read text through a tube that significantly restricted participants' field of vision. Reading rates were significantly reduced to 19.5 words per minute when letters were visible one at a time, and 108.5 words per minute when the reader was able to see a whole word at a time (Troxell, 1967, as cited in Foulke, 1979).

With the introduction of word processing and computer generated documents, format and font have become important visual clues for sighted readers. A sighted person can look at an invitation, outline, research paper, phone book, or grocery list and be able to gather visual information. Within seconds, generalizations are made based on format.

These quick generalizations help to predict the genre and content of the document. A braille reader must read word by word for several words and lines before gathering similar information. Likewise, print readers have immediate visual access to tables, graphs, charts and maps. These graphic images foreshadow information and are important illustrations to the document being read. Sighted people can shift their vision back and forth between the image and the text. Complications for the braille reader include not being able to predict information from the image, difficulty interpreting the tactual graphics, and an inability to shift attention from the image to the text and simultaneously process information. Computer technology has created extra visual cues for print readers such as bold letters, larger font, italics, and underlining. Braille does not vary in size. Visual cues such as bold, font size, italics, and underlining are portrayed by additional braille symbols, called composition signs. All of these formatting and visual cues focus the reader's attention on important information. Given the nature of tactual reading, braille readers have less access to visual cues and images.

Tactual Perception and Processing

Memory has an invaluable role in the brain's ability to process information. Sensory information gathered visually or tactually is sent to the brain. The brain uses prior memory, knowledge, and experiences to interpret the information. Researchers have established differences in tactual versus visual processing.

Brain analysis and mapping provide pictures showing that the sensory register for vision is larger than the tactual register. The limited memory stemming from tactile stimulation has a more rapid rate of attrition, compared with visual stimulation (Rex, Koenig, Wormsley, & Baker, 1995). The rapid decay of tactual memory contributes to the difficulty in learning and retaining braille characters.

Millar (1997) concluded that people have the capacity to store 2 to 3 tactual symbols in their short-term memory. In research comparing tactual memory of adults to tactual memory of children, Millar (1991) provided evidence that memory is linear, meaning that the ability to hold more information at a time develops with age. In another study, Millar found a relationship between retrieval speed and capacity of short-term memory. Adults were able to retrieve information quicker than children because adults have a larger memory bank and can draw from more experiences. Millar's arguments regarding age and retrieval were supported by Hulme, Maughan, and Brown (1991). Sighted children have more experiences with print than children who are blind. Any exposure to print adds to the base of knowledge; therefore sighted people may be able to generalize faster, recognize things more quickly, and have a larger bank of print experiences for the memory to access.

In an experiment involving retaining individual symbols, participants were able to remember more symbols if they were part of a phonological morpheme or word (Millar, 1997). Millar argued that tasks requiring memory of braille symbols increased when the symbols were representations of phonologic morphemes.

Chunking is the ability to group letters, words and phrases when reading. It is a task that requires a "higher level of cognitive functioning (p. 29)" for a tactual reader than the process used by a sighted reader (Rex, *et. al.* 1995). Braille readers who have good comprehension and are rapid readers have the ability to "chunk." Sometimes contracted braille can help with this process, while at other times contracted braille makes decoding more confusing. I have noticed that my students sometimes will spell words out verbally, "un-contracting" the braille contractions, before decoding the word using phonetic cues. Chunking can be a difficult task for students who do not know all of the contractions and the rules of contracted braille. Readers of contracted braille must understand the rules and notations of the code before they can use chunking as an effective reading strategy.

Various theories exist to explain how readers discriminate and recognize braille configurations. In a series of 9 experiments, Nolan and Kederis (1969) showed that braille recognition occurs when an individual associates letters with a global shape. The shape is determined by the number of dots and the location of the dots within the braille cell (right/left, top/bottom). Bürklen (1932) and Ashcroft (1960, as cited in Nolan and Kederis, 1969) conducted similar research and concluded that letters with more than 4 dots accounted for the majority of errors in letter recognition. Millar (1997) presented an alternate theory, suggesting that the "density of constituent dots" determines letter recognition. Through a string of related studies, Millar showed that readers rely on the grouping of dots within the limited space of the braille cell for letter recognition. I often used to wonder why my students were unable to recognize braille when it was written on clothes, jewelry, or when the braille letters are written in "puff" paint. Millar's theory can be used to explain why proficient braille readers are unable to recognize braille shapes when they are not presented in the exact size of a braille cell. In an experiment using large type braille (also known as Jumbo Braille), Lorimer & Tobin (1979) found similar results. They stated that braille readers would have to relearn the symbols when transitioning from large type braille to smaller braille. In this study, Lorimer and Tobin gave one explanation for why Jumbo Braille is not an effective tactual learning media.

Millar (1997) stated that tactual perception is most acute when the braille symbol is raised at least 1 mm. high. Smashed braille is difficult to read. Millar called this "perceptual blurring." The effect is similar to loss in visual acuity due to lack of contrast. Black letters on white paper have the highest contrast resolution. Similarly, embossed dots must have distinguishably raised dots, or high contrast.

Errors in letter recognition are common among braille readers. Nolan and Kederis (1969) attributed this fact to the spacing of dots and the number of dots in the cell. However, Millar (1997) claimed that the errors are due to "dot density." In Millar's theory, readers focus on the closeness of dots. Character recognition errors were often due to the ambiguity of the placement of one dot. The difference in placement of one dot was a measurement less than 2 millimeters. A misperception of this tiny measurement easily leads to significant errors in character recognition. Also, visual closure in braille characters does not exist. In other words, if you cover part of a word or letter in print, it is possible to deduce what the missing part is and it is still legible. In contrast, in braille, if you cover a part of a word or letter by removing a dot, it changes the shape of the configuration, thus entirely changing the symbol's representation. For example, if you remove a dot from the letter *b*, it becomes the letter *a* (b = ⠃; a = ⠁) or the contraction for *ea* or a comma (b = ⠃; ea = ⠂; and , = ⠂).

Researchers have studied the effect of orientation on braille reading. Spatial arrangement is crucial to the recognition of braille letters. Braille readers must position their bodies directly in front of the text for correct spatial orientation. Heller, Calcaterra, Green, and José de Lima (1999) provided evidence for this theory. Participants were asked to read texts presented at 0°, 90° and 180° angles. Participants showed a significant decrease in reading speeds when the texts were presented at 90° and 180° angles.

Scanning techniques are also important factors that contribute to how braille is processed. Millar (1997) made a distinction between active scanning and passive scanning. Her studies showed that fluent braille readers use an active process when reading by scanning their fingers over several words of the text. This is different from a passive technique of reading one character at a time. She distinguished active from passage touch in the following way, “Active touch includes kinesthetic information from exploratory movements (inputs from the muscles, joints, and tendons) in tracing around the raised outline of an object, while in ‘passive touch’ the skin is being touched, possibly by a flat object placed on the skin, so that the information comes mainly from the skin (cutaneous) receptors. (p. 21).” Millar suggested that processing occurs when the fingers actively scan the words. I have seen evidence of this theory when working with my students. In oral reading activities proficient readers scan several words ahead. Therefore, their fingertips were five to six words ahead of the words being read aloud. Struggling or beginning braille readers often scrub individual letters using an up and down motion, while trying to decode each word. The scrubbing method is counterproductive to the fluid scanning motion required for fluent reading.

Influences of Modern Technology

Current Trends in Printed Text Production

Kirschenbaum (2006) stated that concepts of marketing should be applied to the educational materials being provided to our students. She asserted that the colorful marketing strategies, in contrast with the traditional black and white texts, draw the reader's attention. She argued that reading fluency, interest, and retention were higher when her students read text that was visually appealing.

Research in marketing showed that readability affected decision making (Novemsky, Dhar, Schwarz, & Simonson, 2006; Simmons & Nelson, 2006). Written materials that had difficult fonts to read, lead to less confidence in the prediction of outcomes (Simmons & Nelson, 2006). Similarly, reading fluency was affected by the readability of the font and typeset (Novemsky, Dhar, Schwarz, & Simonson, 2006). Marketing strategists have used knowledge about visual layout to create influential advertisements. With the invention of personal computers and the technology revolution, visual presentations are ubiquitous.

In the last decade, textbooks have begun to incorporate visual aspects to create appealing presentations of text. A preliminary analysis of textbooks occurred prior to the development of the materials used for this study. In this analysis, the I found that the textbooks in 1997 were less cluttered and utilized less visual features than the textbooks published after 2004. Vibrant colors characterized the images, backgrounds had subtle watermarks, text was written in color, and various fonts were used to enhance the visual appearance.

These visual features are used for students of all ages and they are seen in every discipline. Students who do not have vision cannot access to the richness of the visual layout seen in educational materials. Transcription into braille may never be able to capture the aesthetics of visual content. However, certain features can be transcribed to be accessible for a tactile reader.

Purpose Statement

Format, color, spatial reference, illustrations, diagrams, typeset, and font are among the visual features that must be transcribed into tactile form. Some of these aspects are easily translated and others are more difficult. For the purposes of this research, I focused on ways to present typeset or words with emphasis. Specifically, I compared the current method of indicating attributes of typeset with two proposed methods for specifying italicized, red, and blue words. The purpose of the study was to propose two alternate formats for presenting typeset that may be an alternative to the current braille code. The design of the new formats may be easier to locate and present less challenges for struggling readers. The research was designed to investigate which of the three formats resulted in faster and/or more accurate location and identification of words with emphasis. Secondary purposes were to investigate students' perceptions and opinions of typeset features. In particular, interview questions were designed to learn about students' prior knowledge and experiences with typeset, and to determine if users had a preference for one of the three formats presented, after the study was completed. The results obtained from the research will be used by BANA to initiate a discussion among educators of the visually impaired and stakeholders to change the way transcribers indicate typeset features in early elementary school textbooks.

The research questions guiding the study were (a) Do differences exist in the speed and/or accuracy of recognizing words presented in the current braille code, as compared with either of the two alternate ways of presenting typeset, and (b) Do the students have a preference for how these indicators are transcribed into braille?

CHAPTER 3: METHODS

Formatting of text using typeset features such as bold, color, underlining and italics is an increasing trend in textbooks for elementary education. The markings are used to indicate essential information such as key words, directions, intonation, or special topics. For the purposes of this study, the term *typeset* will be used to describe attributes of a font used for emphasis, such as bold, italic, color, and underlining, while the term *font* will be used as a generic term to describe the style of the printed alphabet text such as Times New Roman, Arial, or Verdana. The current braille code (CBC) and two alternative *formats* are examined. The term *format* is used to describe the way in which typeset is transcribed into braille using the CBC or the two proposed formats (described in the *Quantitative: Quasi-experimental design* of the Methodology section below). The discussion presented in this study is about the use of the three formats. Mainly, did the use of one format provide faster recognition or/and accuracy when presented to the reader, and did the reader have a preference for one over another?

While the innovative uses of font, color, and typesets have created beautiful visual presentations in children's literature, they present challenges for children reading in braille. Currently, braille readers must learn specific braille composition signs that correspond to various typeset and color changes. For example, dots 4 and 6 preceding a word or words are used to indicate bold, italic, or underlining. These symbols are not instinctively recognizable like visual features of print. They can be easily confused with letters or contractions (parts of words or whole words), and they are not decipherable without systematic and sequential instruction. BANA and ATIC (2006) stated that the composition symbols can change the shape of a word, thus causing confusion. Students must memorize the symbols and be able to identify them while reading. To illustrate, if in an assignment a child were required to list all italicized words found in a passage, the braille reader must scan the passage deliberately and locate each symbol, while making sure not to confuse it with a letter or a part of a word. In contrast, a sighted child can quickly glance at a page and instantly recognize the italicized words. This task is especially difficult for a beginning reader who is learning to decode and who has not learned all of the braille contractions. Regardless of reading level or age, one fact remains: braille readers are slower than sighted readers at recognizing important information offset by typeset changes.

Furthermore, because typesets are visual features, students must learn concepts of print to comprehend the terms bold, italic, and underlining. Unfortunately, even with training and great conceptual development, because the current braille code uses the same symbol (dots 4 and 6) for all three typeset changes, students would require assistance to identify which typeset is being used.

Ultimately, tasks using the current braille standards for presenting typeset are more difficult for a child with a visual impairment, as compared with their sighted peers. First, recognition of typeset indicators is delayed. Second, the child must have been introduced to the braille symbols prior to being expected to complete a task. Third, these symbols can interrupt the flow of text and impact reading fluency.

To assist teachers who teach braille literacy to early elementary aged children, the Early Literacy Materials Production Committee of BANA and the Accessible Textbooks

Department (ATIC) of the American Printing House for the Blind (APH) have established guidelines for when to introduce braille composition signs and how such changes to text should be transcribed for early braille readers, (ATIC & BANA, 2007). As part of their charge in developing these guidelines, the Early Literacy Materials Production Committee of BANA has initiated and sponsored this dissertation project. New methods of indicating typeset have been considered for proposal by the Early Literacy Materials Production Committee of BANA, as part of their charge to investigate the use of words with emphasis in early elementary textbooks (ATIC & BANA, 2007). The proposed methods were designed so that children who read braille can quickly find words written in various typesets without interrupting the flow of text or impacting reading fluency.

In the following mixed method quasi-experimental research, the author investigated two alternate formats for presenting typesets, comparing them to the current braille code. The purpose of the research was to investigate alternate methods of presenting typesets that would not interfere with the flow of text and affect reading fluency. The research was funded by BANA and approved by the University of Arizona Institutional Review Board (IRB – see Appendix A). Participants were children who read braille, ages 7-9, and their teachers of the visually impaired who collected data. Measurements of speed and accuracy in locating, identifying, and reading words written in italics, red, or blue were analyzed. A secondary purpose of the research was to investigate student perceptions and opinions about the ways in which typesets were presented. The research questions guiding the study were (a) Do differences exist in the speed and/or accuracy of recognizing words presented in the current braille code, as compared with either of the two alternate ways of presenting typeset, and (b) Do the students have a preference for the ways these indicators are transcribed into braille?

Methodology

Research Design: Mixed Methods

A mixed methods design was used, including data collection and analysis of quantitative measures of speed and accuracy and analysis of qualitative data gathered from student interviews. For each of the following sections (methods, procedures, data collection, and data analysis), information pertaining to the quantitative portions of the study will be discussed first, followed by information regarding the qualitative portions of the study.

Quantitative: Quasi-experimental design

A quasi-experimental design was used to establish if a difference in speed or accuracy existed when typesets were presented in the *Current Braille Code* (CBC), as compared with two alternate braille formats, *underlining with emphasis indicator after the underline* (U_a) and *underlining with emphasis indicator before the underline* (U_b). Table 3.1 Examples of font indicators, shows the three formats of indicating typeset in braille that were used in the study (See also Appendix B). As illustrated in the figure, the format varied slightly for a one cell word, multiple cell word, and/or multiple words. Parts of words (i.e. italicizing part of a word - *base*ball) and series of more than four words are not shown because they were not included in the study.

Table 3.1 - Examples of Font Indicators (See also Appendix B)

	Single Word	Multiple Words (< 4 words indicated)
CBC		
Italics	The fox *jumped*. ⠠⠮ ⠋⠕⠭ ⠨⠚⠥⠍⠏⠫⠲	See the *brown dog*. ⠠⠎⠑⠑ ⠮ ⠨⠃⠗⠪⠝ ⠨⠙⠕⠛⠲
Bold	John is **happy**. ⠠⠚⠕⠓⠝ ⠊⠎ ⠨⠓⠁⠏⠏⠽⠲	He is a **very nice cat.** ⠠⠓⠑ ⠊⠎ ⠁ ⠨⠧ ⠨⠝⠊⠉⠑ ⠨⠉⠁⠞⠲
Underline	I like soda for lunch. ⠠⠊ ⠇ ⠨⠎⠕⠙⠁ ⠿ ⠇⠥⠝⠡⠲	I can learn braille. ⠠⠊ ⠨⠉ ⠨⠇⠊⠜⠝ ⠨⠃⠗⠇⠲
Red Font	The mouse is quick! ⠠⠮ ⠍⠳⠎⠑ ⠊⠎ ⠸⠗ ⠟⠅⠲ ⠠⠄	May I have more peas? ⠸⠗ ⠠⠍⠁⠽ ⠠⠊ ⠠⠄ ⠓ ⠍ ⠏⠂⠎⠦
Blue Font	I will not go home. ⠠⠊ ⠺ ⠝ ⠛ ⠸⠃ ⠓⠕⠍⠑⠲ ⠠⠄	People do not want it. ⠠⠏ ⠸⠃ ⠙ ⠝ ⠺⠁⠝⠞ ⠠⠄ ⠭⠲
U_a		
Italics	The fox *jumped*. ⠠⠮ ⠋⠕⠭ ⠚⠥⠍⠏⠫⠲ ⠉⠉⠉⠉⠉⠊	See the *brown dog*. ⠠⠎⠑⠑ ⠮ ⠃⠗⠪⠝ ⠙⠕⠛⠲ ⠉⠉⠉⠊ ⠉⠉⠉⠊
Bold	John is **happy**. ⠠⠚⠕⠓⠝ ⠊⠎ ⠓⠁⠏⠏⠽⠲ ⠉⠉⠉⠉⠉⠃	He is a **very nice cat.** ⠠⠓⠑ ⠊⠎ ⠁ ⠧ ⠝⠊⠉⠑ ⠉⠁⠞⠲ ⠉⠃ ⠉⠉⠉⠃ ⠉⠉⠉⠉⠃
Underline	I like soda for lunch. ⠠⠊ ⠇ ⠎⠕⠙⠁ ⠿ ⠇⠥⠝⠡⠲ ⠉⠉⠉⠥	I can learn braille. ⠠⠊ ⠉ ⠇⠊⠜⠝ ⠃⠗⠇⠲ ⠉⠥ ⠉⠉⠉⠥ ⠉⠉⠉⠥
Red Font	The mouse is quick! ⠠⠮ ⠍⠳⠎⠑ ⠊⠎ ⠟⠅⠲ ⠉⠉⠗	May I have more peas? ⠠⠍⠁⠽ ⠠⠊ ⠓ ⠍ ⠏⠂⠎⠦ ⠉⠉⠉⠗ ⠉⠗
Blue Font	I will not go home. ⠠⠊ ⠺ ⠝ ⠛ ⠓⠕⠍⠑⠲ ⠉⠉⠉⠉⠃	People do not want it. ⠠⠏ ⠙ ⠝ ⠺⠁⠝⠞ ⠭⠲ ⠉⠃⠉⠃ ⠉⠉⠉⠃
U_b		
Italics	The fox *jumped*. ⠠⠮ ⠋⠕⠭ ⠚⠥⠍⠏⠫⠲ ⠊⠉⠉⠉⠉⠉	See the *brown dog*. ⠠⠎⠑⠑ ⠮ ⠃⠗⠪⠝ ⠙⠕⠛⠲ ⠊⠉⠉⠉ ⠊⠉⠉⠉
Bold	John is **happy**. ⠠⠚⠕⠓⠝ ⠊⠎ ⠓⠁⠏⠏⠽⠲ ⠃⠉⠉⠉⠉⠉	He is a **very nice cat.** ⠠⠓⠑ ⠊⠎ ⠁ ⠧ ⠝⠊⠉⠑ ⠉⠁⠞⠲ ⠃⠉ ⠃⠉⠉⠉ ⠃⠉⠉⠉

Underline	I like <u>soda</u> for lunch. ⠠⠊ ⠇ ⠎⠕⠙⠁ ⠿ ⠇⠥⠝⠡⠲ ⠥⠉⠉⠉	I <u>can learn braille</u>. ⠠⠊ ⠉ ⠇⠑⠜⠝ ⠃⠗⠇⠲ ⠥⠉ ⠥⠉⠉⠉ ⠥⠉⠉⠉
Red Font	The mouse is quick! ⠠⠮ ⠍⠳⠎⠑ ⠊⠎ ⠟⠅⠖ ⠗⠉⠉⠉	May I have more peas? ⠠⠍⠁⠽ ⠠⠊ ⠓ ⠍ ⠏⠂⠎⠦ ⠗⠉⠉⠉ ⠗⠉
Blue Font	I will not go home. ⠠⠊ ⠺ ⠝ ⠛ ⠓⠕⠍⠑⠲ ⠃⠉⠉⠉⠉	People do not want it. ⠠⠏ ⠙ ⠝ ⠺⠁⠝⠞ ⠭⠲ ⠃⠉⠃⠉ ⠃⠉⠉⠉

The *Current Braille Code* (CBC) made use of a composition sign preceding the word/s with emphasis indicators for color, bold, italics or underline. The symbol for bold, italics or underline was a single cell, dots 4 and 6, before a group of four words or less (i.e. *cat* was written ⠨⠉⠁⠞, where the ⠨ denoted that the word was written in italics). For the purposes of the study, all words with this symbol were considered italicized; because no distinction existed in CBC for words written in bold, underline, or italics. Additional symbols are used to denote a string of four or more words, but were not included in this study. For words written in color, the symbols preceding a word/s were dots 4, 5, and 6 followed by the letter "r" for red or "b" for blue, and a space. When composition signs for color were used, a termination indicator was required following the colored word [i.e. cat = ⠸⠃ ⠉⠁⠞ ⠠⠄ (where ⠸⠃ denoted that the word was blue and the ⠠⠄ indicated the termination of blue words)].

The two alternate typeset indicators proposed in this dissertation were *underlining with emphasis indicator after the underline* (U_a) and *underlining with emphasis indicator before the underline* (U_b), (see Appendix B). Both alternatives utilized an additional line space under the line of text that included the word/s with a typeset change. The indicator was located in the additional line space. The purpose of the added line was to create emphasis to the typeset change by offsetting the text, thereby providing the reader with an efficient way to scan and locate the typeset indicator. Theoretically, the extra line spacing would be found with a quick exploration of the entire page using two hands. Essentially, using the U_a or U_b method, the reader could sweep an entire page, from top to bottom, in search of an extra line break in the text. Once the line break was found, the reader could explore the empty line and find a tactile marking that would indicate the typeset change of the word/s. The word/s with an emphasis would be directly above the markings found in the extra line spacing. The proposed method also had indicators to differentiate between italics, underline, and bold; whereas the CBC did not differentiate between these three typesets. However, words presented in this study did not include underline or bold because these emphasis indicators could not be distinguished in CBC.

The independent variables were three ways of presenting typeset CBC, U_a, and U_b. The dependent variables were two measurements: speed (measured in seconds) and accuracy (measured by number of correctly identified words and typesets). Using a point system, three measures of accuracy were obtained: word recognition, typeset identification, and overall accuracy, as explained in the data collection section below.

Because of the low incidence of students with visual impairments, a random sampling could not be acquired. Solicitation of participants occurred by word of mouth and/or by responding to a call for participants sent out on local and state-wide internet list-serves. Thus, a quasi-experimental design was used. Participants were divided into three groups following a schedule of assigned probes (see Table 3.2). The schedule was designed to reduce carry-over effects, randomize the administration of tasks, and prevent order from impacting scores. Each story was transcribed into all three formats to ensure that the difficulty of the task was not influenced by the differences between passages. Participants were then assigned to each group. To simplify the data collection procedures for participating teachers with more than one student in the study (two teachers had two students in the study, and one teacher had three students), random assignment to groupings did not occur. Materials were distributed based on the groupings denoted on the schedule. Data from repeated measures were taken from each of the three probes (CBC, U_a, and U_b). Each probe included several activities and a post-test, as described in the procedures section. Scores from the post test were used in the data analysis.

Table 3.2 – Order of typeset by probes and story titles for each group

	Probe 1	Probe 2	Probe 3
Group A	CBC – *My Black Panther*	U_a – *Owls*	U_b – *My New Fishing Rod*
Group B	U_a – *My Black Panther*	U_b – *Owls*	CBC – *My New Fishing Rod*
Group C	U_b – *My Black Panther*	CBC – *Owls*	U_a – *My New Fishing Rod*

Qualitative design

A qualitative design was used to investigate students' perceptions and opinions about the various formats. Pre-instruction and post-instruction student interview data were collected. Each interview was audio-recorded and transcribed for analysis. Questions were designed to gather information regarding students' prior knowledge with typesets and students' preferences for using the CBC, U_a, or U_b. The pre-instruction and post-instruction interview questions are listed below:

Pre Instruction Interview Questions

1. Have you ever seen words in your book that are italicized, colored, underlined or bolded? (1a) How do you know when a word is "different"? (1b) Do you know the braille symbols?
2. Can you describe what typeset changes may look like in print?
3. Why do you think print books make some words "different"?
4. Do you think finding the words that are "different" is important?
5. What do you do when you find these words?

Post Intervention Interview Questions

1. When you were scanning the stories, how did you know when a word/s was different?
2. Which way did you like better (CBC = Current Braille Code, U_a = Underlining with letter indicator after the underline, and U_b = Underlining with letter indicator before the underline)?
3. Why did you like it better?
4. Did the exercises that you did change the way you might think about some words?
5. Would you change the way you look at the story if you had the words underlined (U_a or U_b)?

Sample

Recruitment procedures took place by word of mouth and through local and state agency list-serves (i.e. AER list-serves) see Solicitation of Participants (Appendix C). Although nearly 40 teachers responded to the call for participants, only twenty-five Teachers of the Visually Impaired (TVIs) met the criteria, obtained necessary permission, and participated in the study. The call for participants included selection criteria details. Proficient braille readers ages 7 to 9 years old whose primary reading medium was braille were invited to participate. Braille proficiency was defined as reading text at an ending first-grade or beginning second grade level at a rate of 30 words per minute or faster, using single-spaced braille, and knowing at least 90% of the braille code. Only TVIs who verified that their students met specified qualifications were asked to participate. Requirements for the TVIs included knowledge of the rules and contractions of the English Braille Code and familiarity with the composition signs for typesets. Through participation in the study, they became familiar with the proposed symbols for U_a and U_b. Compensation up to $100.00 for participating TVI and $25.00 for students was available and advertised in the Solicitation for Participants.

TVIs assisted in obtaining the necessary permission, by corresponding with the family and student, encouraging them to read and sign the University of Arizona's Institutional Review Board (IRB) approved consent form (see Appendix D) and assent form (see Appendix E). Assent and consent forms also were translated into Spanish and sent home to children whose parents were Spanish speaking. Additionally, TVIs helped obtain Site Authorization from a school district administrative representative (i.e.

principal or director of special education; see Appendix F). Signed consent/assent forms and site authorizations were placed in a locked cabinet in the Division of Special Education and School Psychology at the University of Arizona. TVIs who agreed to participate were informed of their role in the research study, prior to receiving materials for instruction.

Students (n = 30), from 10 different states, who were in mainstream settings and specialized schools for the visually impaired, participated (see table 3.3 for age and sex of participants). One student dropped during the first probe of the study, because she was not able to follow the directions to complete the task. The TVI reported that the task of "scanning" was too difficult. The student was not able to read some words; rather she deliberately read every word of the passage out loud. Another student was only able to complete two of the three probes, and data from his probes were not included in the statistical analysis of speed and accuracy. Compensation of $100.00 was given to TVIs who provided instruction and completed data collection. Also, students who completed the study were paid $25.00. Funding for compensation was provided by BANA.

Table 3.3 – Student demographics

	Age at time of completion of the study		
	7	8	9
Males	1	6	7
Females	6	4	4
Total	8	10	11

Materials

Materials Development

A survey of four second grade language/arts textbooks was conducted prior to the development of the materials used in this study. Textbooks were chosen based on state adopted language arts curriculum and were limited to textbooks used in California and Texas. Copyright dates ranged from 1997 to 2006. This preliminary research was important in determining which indicators were used most frequently (i.e. italics, bold, underline, colored words, highlighting). All textbooks examined incorporated several fonts, color, and typeset features. Visual features included the incorporation of color with changes to the font or typeset. For example, decorative banners, often used for titles of the selections, were artfully illustrated with multi-colored words and fancy font styling. Similar banners also were used for headings and special activities (i.e. a red and blue banner, with yellow and white font and an illustration of a microscope, indicated a science activity). Authors of the selections also were written using various fonts, font sizes, and colors. Sidebars were offset from other information on the page using colored boxes, in which the information was written in a contrasting color (i.e. yellow font in a dark green box). These examples of visual features typically would not be transcribed into braille, because they are not essential to the reader. Rather, these visual features would be considered embellishments that make the material more interesting and motivating for a sighted learner. Illustrations and photographs that are essential to comprehension would be described using transcriber’s notes. Graphs, charts, and maps would be converted into a tactile format and included in the braille versions of textbooks.

In the preliminary analysis of textbooks, I was particularly interested in critical information embedded within the text. For example, the words “monitor” and “predict”, written in bold, were essential key words and concepts being taught as reading strategies in the sentence, “While you read about Maya and Julius, **monitor** how well you understand the story. If you’re not sure about something, reread or read ahead to **clarify**.” (p. 43, Houghton Mifflin, 2006). Also, in the sentence, “A poem **describes** things, tells a **story**, or makes you **feel** a certain way.” (p. 111, Houghton Mifflin, 2006), “describes,” “story,” and “feel” are written in green to emphasize the meaning of these words, and in the sentence, “Max responded by patting the bucket, *Tap-tap-tap. Tippy tip… tat-tat*.” (p. 75, Harcourt Brace, 1997) words are italicized to reinforce concepts being taught in the selection. Typeset and font can be used simultaneously, as seen in the directions for an extension activity, “Make a chart with three columns. Label one column **L** for *Living*. Label the second column **N** for *Non-living*. Label the third column **O** for *Once-Living*.” (p. 111, Houghton Mifflin, 2006).

Approximately 150 pages of each book were analyzed page by page, including the title pages, table of contents, glossary, and first unit. Data were collected each time a change to the typeset, color, or font was made. Changes were grouped in the following categories: titles, authors, headings, titles of sidebars, directions, keywords, or directions/strategies. Results of the analysis of textbooks showed that all textbooks used various fonts, colors, highlighting, and typeset features. The most common features were visual presentations that typically would not be transcribed into braille such as titles, headings, titles of sidebars, and authors. The attributes to text that were essential to the reader were most often used for vocabulary words, concepts, key points, literary terms, or reading strategies. The two textbooks from 1997 had the least amount of features, and the 2006 textbook used a significantly higher number of features. The layout and usage of attributes were consistent throughout each of the textbooks. For example, in the SRA (1997) textbook following each selection, a short biography about each author and illustrator was included, in which the author's name was written in a larger, darker blue font, for example, "**B. G. Henessy** worked as a book designer and an art director for children's books. (p. 38)" Houghton Mifflin (2006), the textbook that used visual features the most, had several sidebars per page. However, each consistently used the same color scheme, placement, font, shape of the banner, etc. for the sidebars representing similar content or activities. Also, Houghton Mifflin consistently used yellow highlighting for all vocabulary words and italics to highlight or emphasize words within the text.

The analysis reinforced the need for the study. Although the sampling was limited to four textbooks, the increase in visual attributes in the two textbooks published in 2002 and 2006 indicated that graphic images and visual appeal are on the rise. With regards to the most commonly used features, within each textbook consistency occurred in the number of times an attribute was used, but between textbooks, none were used more frequently than others. All features were used. Based on the preliminary analysis and the restrictions of the current braille code (italics, underline and bold use the same symbol), this study was limited to typeset indicators for red, blue, and italics.

A pilot set of materials was created prior to the production of multiple sets. During the pilot testing the number of indicators per passage was increased from 10 indicators to 30 indicators. The increase in the number of indicators added power to the statistical analysis. Also, the initial pilot set of materials had one-page passages. The final set of materials had passages that were two pages in length. Directions for the instructor were included in the pilot set and a TVI was included in the testing of the pilot set of materials. Comments from the TVI assisted in the creation of the final set of the directions.

Materials Used

Materials needed for each session included the following: instruction cards for the TVI, braille materials for the students, a stopwatch timer, and data collection sheets. Each probe included professionally transcribed braille word cards, sentences, practice reading passages, and a test. Materials were separated into envelopes, one for each probe (CBC, U_a, U_b). In the envelope, teachers were given detailed instruction cards, braille materials, and corresponding print copies for each activity within a probe. Three activities were included in each probe (word cards, sentences, passages). The passages were selected from the Houghton Mifflin 2.1, second grade textbook. Words for the word cards were selected from the passage, and these words were used to create sentences. Researcher-designed data collection sheets were provided for the practice and test passages. Also, the participating TVI used an audio recorder to tape the pre-instruction and post-instruction interviews.

Procedure

Quantitative

Probes: Instruction and testing. Based on the assigned groupings, each student participated in 3 probes, one for each proposed format: CBC, U_a, U_b. As previously stated, the order in which formats were presented was determined by group assignment (refer back to table 3.2). Also, each story (*My Black Panther*, *Owls*, and *My New Fishing Rod*) was transcribed into each of the three formats. Red, blue, and italics were the only typesets presented in the study. Instruction took place in their regular school environment for several sessions, each lasting no longer than 45 minutes. Procedures for each probe included the same three activities, as described below.

Activity 1. The first activity was to learn the typeset symbols for red, blue, or italicized words. Word cards were used to introduce students to the typeset indicators. Two sets of thirty cards were held together by "O" rings. Seven words and three phrases (two or three words) were written in braille; see Appendix G for a list of words. Words and phrases were triplicated using each of the three types of indicators (blue, red, and italics). Teachers were asked to shuffle the cards and present them one by one to the student. Students read the word and stated the indicator. A second set of cards was available if the TVI felt that the student needed additional practice.

Activity 2. Two sets of ten sentences and two pre-tests were included in each probe (see Appendix H). Students were presented with the first set of sentences and were asked to tactually scan and locate the typeset indicator. They were told to verbally state only the word/s that had a typeset indicator, and state which indicator it had (red, blue, or italic). After completing ten sentences, students were given a pre-test consisting of 5 sentences. They were asked to repeat the task for the pre-test. If the student correctly identified the word and typesets for all five sentences, then they progressed to the third activity. If the student scored less than 100% on the pretest, then the TVI repeated activity two with the second set of sentences.

Activity 3. Activity three consisted of scanning and locating the word/s in a passage (see Appendix I). Two practice passages and a test passage were included for each probe. TVI were asked to introduce the passage to the student and instruct the student to scan the page in search of typeset indicators. Students read aloud the word and stated the typeset indicator. Using researcher developed data collection sheets, the TVI recorded the number of words identified accurately, the number of typesets identified correctly, and the number of seconds spent on the task (see Appendix J). Passages ranged in length from 214 to 312 words and included 30 words with indicators. Students completed at least one of the two practice reading passages, before taking the test. A second passage was available if the teacher felt that the student required additional practice, before taking the test. The same instructions and procedures were used for each probe.

Qualitative

Interviews. Two interviews with each participant took place. TVI audio recorded both interviews. The pre-instruction interview was given prior to the first probe (refer to page 54 & 55). Data were gathered regarding the students' prior knowledge and concept development. In particular, did the student have prior exposure to braille words written in bold, italics, or color, and did the student have an understanding print-concepts related to typeset changes? A post-instruction interview was given after the third probe, to determine which format students preferred (CBC, U_a or U_b) and to find out if the instruction made a difference in students' conceptual understanding of typeset.

Data Collection

Quantitative Data

A Repeated Measures design was used to collect data from thee probes. Two types of quantitative data were collected during the third activity of each probe: overall accuracy and time in seconds. TVI recorded student performance on the data collection sheets provided (see Appendix J), using the following system: 2 points for each word that was read correctly and the typeset accurately identified (overall accuracy = 60 points per passage); 1A point for each word that was read correctly, but the typeset was incorrectly identified (word recognition accuracy = 30 points per passage); 1B for each word that was incorrectly read, but the typeset was accurately identified (typeset identification accuracy = 30 points per passage); and 0 points if the student was unable to identify the word and typeset. Using the point system, three subsets of data were obtained: overall accuracy, word recognition accuracy, and typeset identification accuracy. In addition, the TVI recorded how many seconds each student took to complete the task.

Qualitative Data

TVI interviewed the students before the first probe and after the last probe. Questions were purposefully designed with objectives in mind to obtain information about prior knowledge, conceptual development, processes, preference, and opinions (refer to pages 54 and 55). Each interview was audio-taped using a variety of methods (i.e. digital voice recorder, computer software, micro-cassette, or cassette). Teachers were informed that they were to ask the questions verbatim, but could reword the question or ask follow-up questions if necessary. Audio-recordings were transcribed for analysis.

Data Analysis

Quantitative data

Raw data from the data collection sheets were input into SPSS for analysis. Repeated Measures Analysis of Variance (ANOVA) was used to analyze measures of speed and accuracy. Significance was determined at a p value of less than .05. Within subjects variables were defined as format, and between subjects variables were defined as order (order in which typeset were presented to students, based on groupings). Four separate ANOVA tests were run: Speed, Overall Accuracy, Word Identification Accuracy, and Typeset Identification Accuracy. Post-hoc analyses consisting of pair-wise contrasts were conducted only on tests of significance. Mean scores of the interaction of the main effect and between subjects effects were graphed and are presented in tables and figures for each analysis.

Additional analyses included two correlational tests. A bivariate, Bonferoni approach was used to calculate correlation coefficients. Significance was determined at a p value of less than .01 (2-tailed). Correlation coefficients for speed and overall accuracy were calculated. Also, correlation coefficients for word identification accuracy and typeset identification accuracy were calculated.

Qualitative Data

Audio recordings from the pre and post-interviews were transcribed. Based on the transcriptions, interview data were analyzed quantitatively and qualitatively. Frequency of occurrence provided quantitative data for responses that were similar. For example, the number of students who had prior exposure to typeset features was acquired from the pre-instruction interview. Similarly, data from the post-interview questions was quantified to show the number of students who preferred each of the formats presented (CBC, U_a or $U_{b)}$. For the post interview question, "Which way did you like better (CBC, U_a or U_b)?" only the first response was calculated, because some teachers influenced children to change their responses. For example, in one situation a child responded that he preferred Ub, after hearing his response, the teacher replied, "Really? I don't think so." The child then responded that he preferred CBC. Similar situations occurred, therefore to maintain consistency and to reduce teacher biases; only the first response was calculated. In the analysis of other questions, multiple responses were calculated in frequency counts.

Data also were analyzed qualitatively, and results presented in Chapter 4 include several direct quotations or paraphrases of children's responses. The responses were categorized and organized by similarity. Some responses were rich in providing insight regarding students' prior knowledge of typesets, conceptual understanding of print, and perceptions of braille. These statements were classified into tables. For example, students' responses that illustrated an understanding of print concepts were organized into three categories: (a) comments demonstrating knowledge of differences between tactile materials and printed materials (b) comments demonstrating knowledge of differences between print and braille related to braille contractions and spelling, and (c) random statements.

Summary of Methodology

The purpose of the study was to determine the speed and accuracy of recognizing words with typesets (italics, red, and blue) when presented in continuous text. Participants in the study were children ages 7 to 9 years old who read braille as their primary reading medium. They were asked to scan and locate words with typeset features in a passage. TVI collected data on their responses and the time spent on the task. Pre and post instruction interviews were also conducted. Measures of speed and accuracy were analyzed to answer the first research question, “Do differences exist in the speed and/or accuracy of recognizing words presented in various formats?” Interview data were used to answer the second research question, “Do the students have a preference for how these indicators are transcribed into braille?” Results are presented in Chapter 4.

CHAPTER 4: RESULTS

Results were obtained from quantitative measures and from interview data. The following section is organized into two sections: quantitative results based on measurements of speed and accuracy, and qualitative results based on pre and post-interviews of students. The term *format* is used to describe each of the three braille formats (a) current braille code = CBC, (b) underlining with the letter emphasis after = U_a, and (c) underlining with the letter emphasis before = U_b. All three formats were tested. The term *typeset* is used to describe the specific typeset attributes that were tested (a) italics, (b) red, and (c) blue. Despite pre-interview questions inquiring about words in bold or words that are underlined, only italics, red, and blue typeset attributes were used in the testing materials.

Quantitative Results

The first research question was, "Do differences exist in the speed and/or accuracy of recognizing words when presented using various formats (CBC, U_a, U_b), for typesets (italics, red, or blue)?" Results from the quantitative measures of speed and accuracy were used to answer this question. A statistically significant difference between the speeds at which students used the three formats existed. No differences existed in the accuracy at which they used the various formats. Additional detail is presented below.

Speed

A repeated measures ANOVA was conducted with the within subjects factor being format and the dependent variable being speed (as measured in seconds). The estimated means and standard deviations are presented in table 4.1 below. The within-subjects ANOVA showed a significant difference between the three formats presented (CBC, U_a and U_b), $F(2,50) = 3.196$, $p = .049$, $\eta^2 = .113$. In other words, results showed a statistically significant difference in the speed at which students located and identified the symbols. Estimated marginal within subjects means for each format showed that students performed fastest when using U_b ($\mu = 313.167$, SD = 27.022), as compared with U_a ($\mu = 341.583$, SD = 35.766), or CBC ($\mu = 376.917$, SD = 33.239) which took students the longest. While statistical significance was found between the three groups means (speed for CBC, U_a, U_b), when pair-wise contrasts were conducted, no statistically significant differences were found. In other words, pair-wise analysis did not reveal that using one format was faster than using either of the other two formats. Rather, the overall significance was interpreted in the following way: differences existed between each of the three means, with the fastest mean score being when U_b was used.

Table 4.1 – Estimated means and standard deviations for speed

	CBC	U_a	U_b	Marginal B/N Subjects Means
Group A	Probe 1	Probe 2	Probe 3	
	$\mu = 423.400$	$\mu = 419.800$	$\mu = 306.400$	$\mu = 383.200$
	SD = 55.313	SD = 59.518	SD = 44.968	SD = 47.808
Group B	Probe 3	Probe 1	Probe 2	
	$\mu = 355.200$	$\mu = 367.200$	$\mu = 341.600$	$\mu = 354.800$

	SD = 55.313	SD = 59.518	SD = 44.968	SD = 47.808
Group C	Probe 2	Probe 3	Probe 1	
	μ = 351.750	μ = 237.750	μ = 291.500	μ = 367.200
	SD = 61.842	SD = 66.543	SD = 50.276	SD = 53.451
Marginal W/N	μ = 376.917	μ = 341.583	μ = 313.167	
subjects Means	SD = 33.239	SD = 35.766	SD = 27.022	

μ = Estimated Means; SD = Standard Deviation

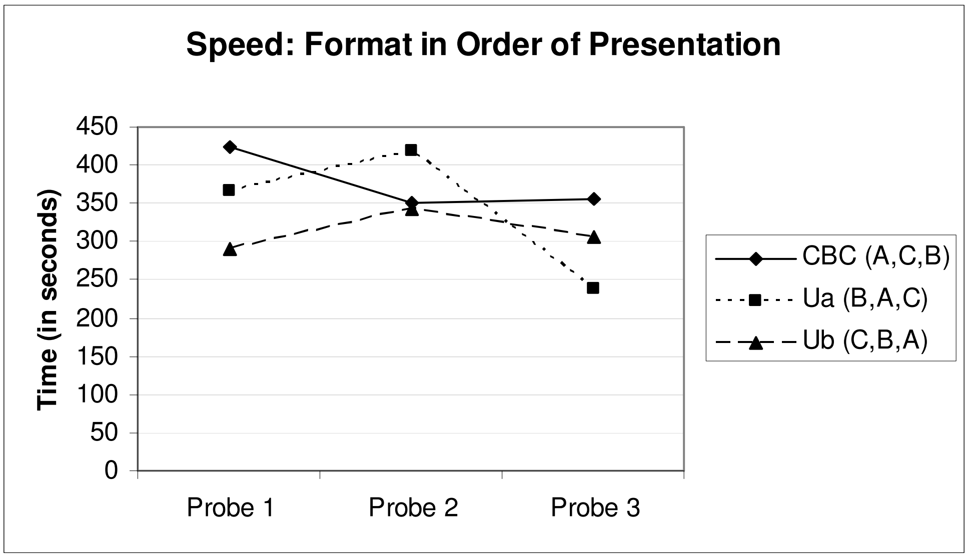
Additional testing revealed no significant differences in the interaction of order and speed $F(4,50) = 2.445$, $p = .058$, $\eta^2 = .164$. Recall that students were placed into three groups, and each group received a different order (Group A – CBC, U_a, U_b; Group B – U_a, CBC, U_b; and Group C – U_b, CBC, U_a). The rationale for varying the order of introduction of formats, by grouping students, was to control for order and difficulty of the passages. The means for speed using each format are presented in table 4.2, in the order in which each format was presented. A line graph of these means is shown, in figure 4.1. Generally speaking, students varied in speed across probes. Maturation did not occur. In other words, they did not get faster at the task, with each successive probe.

Table 4.2 – Overall speed - shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
CBC (A,C,B)	423.400	351.750	355.200

Ua (B,A,C)	367.400	419.800	237.750
Ub (C,B,A)	291.500	341.600	306.400

Figure 4.1 - Means of speed for each format in the order that each was presented



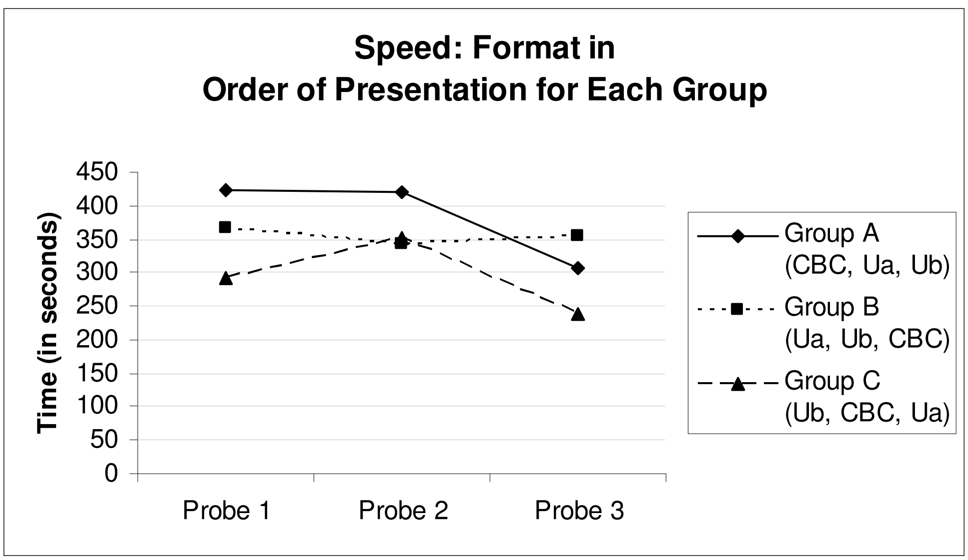
When speed was analyzed with order as the between subjects factor, no significant difference was found $F(2,25) = .798$, $p = .060$, $\eta^2 = .060$. The fact that the between subjects test was not significant verified that the order in which students were introduced to various formats of typesets did not make a difference, and the passages were similar in difficulty. Table 4.3 shows the between subjects means, in the order in which they were presented to each group. A graph of these means is shown in Figure 4.2.

Table 4.3– Between subjects' means for speed – shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3

Group A			
(CBC, Ua, Ub)	423.400	419.800	306.400
Group B			
(Ua, Ub, CBC)	367.200	341.600	355.600
Group C			
(Ub, CBC, Ua)	291.500	351.750	237.750

Figure 4.2 - Means of speed for each format in the order they were presented to each group



Overall Accuracy

A repeated measures ANOVA was conducted with the within subject factor being format and the dependent variable being overall accuracy, a score was comprised of the number of correctly identified words and typesets, as measured in points (out of 60 points total). The estimated means and standard deviations for overall accuracy are presented in table 4.4 below. The results for the ANOVA indicated that no significant difference exists within subjects in overall accuracy using the three formats presented, $F(2,50) = 1.667$, $p = .199$, $\eta^2 = .063$. Pair-wise contrasts were not conducted because overall statistical significance was not found. Using the overall accuracy (based on 60 points) for all three formats, students' correctly identified the typeset and word approximately 85% to 89% of the time (CBC = 89%, U_a = 85% and U_b = 87%).

Table 4.4 – Estimated means and standard deviations for overall accuracy

	CBC	U_a	U_b	Marginal B/N Subjects Means
Group A	Probe 1	Probe 2	Probe 3	
	$\mu = 52.600$	$\mu = 48.100$	$\mu = 53.100$	$\mu = 51.267$
	SD = 4.326	SD = 9.983	SD = 6.420	SD = 2.064
Group B	Probe 3	Probe 1	Probe 2	
	$\mu = 53.400$	$\mu = 51.800$	$\mu = 48.00$	$\mu = 51.067$
	SD = 4.624	SD = 9.041	SD = 11.136	SD = 2.064
Group C	Probe 2	Probe 3	Probe 1	
	$\mu = 54.43$	$\mu = 52.750$	$\mu = 55.38$	$\mu = 54.208$
	SD = 5.732	SD = 9.867	SD = 5.680	SD = 2.308
Marginal W/N	$\mu = 53.43$	$\mu = 50.750$	$\mu = 51.93$	

subjects Means	SD = 4.741	SD = 9.481	SD = 8.55

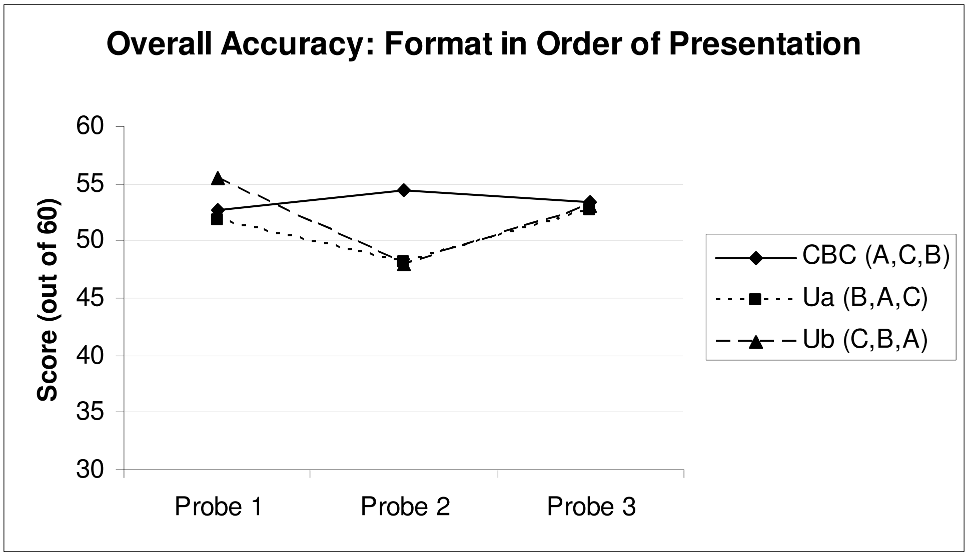
μ = Estimated Means; SD = Standard Deviation

The interaction of overall accuracy and order was not significant, $F(4,50) = 2.050$, $p = .102$, $\eta^2 = .141$. The means for each format are presented in table 4.5 below in the order in which each was presented. A line graph of these means also is presented (see figure 4.3).

Table 4.5 – Overall accuracy shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
CBC (A,C,B)	52.600	54.430	53.400
Ua (B,A,C)	51.800	48.100	52.750
Ub (C,B,A)	55.380	48.000	53.100

Figure 4.3 – Means for overall accuracy for each format in the order that each was presented



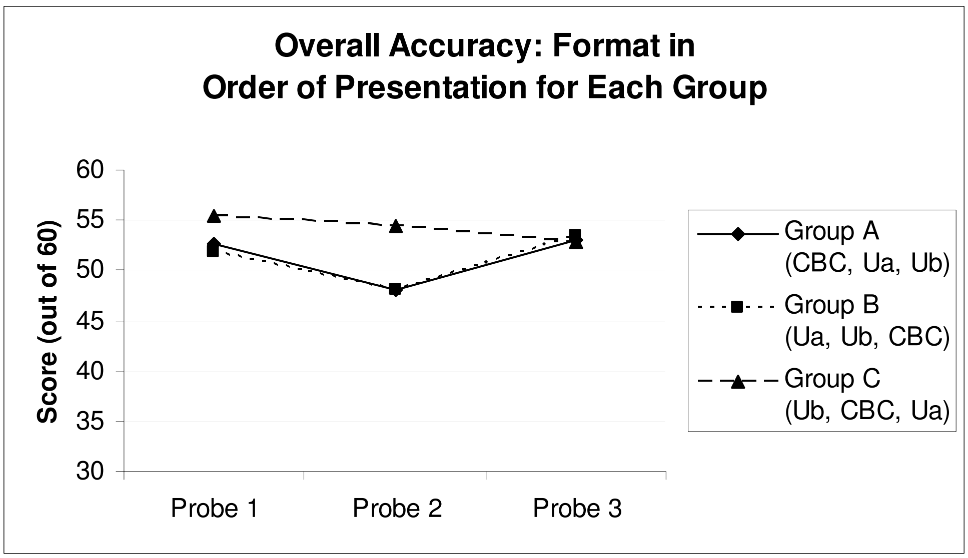
Furthermore, when order was analyzed as the between-subjects factor, it did not have an effect, $F(2,25) = 0.623$, $p = .047$, $\eta^2 = .047$. No significant differences further supports the fact that order did not have an effect and performance of the task using the different passages was equal in difficulty (see table 4.6 and figure 4.4).

Table 4.6 – Between subjects' means for overall accuracy - shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
Group A			
(CBC, Ua, Ub)	52.600	48.100	53.100
Group B			
(Ua, Ub, CBC)	51.800	48.000	53.400

Group C			
(Ub, CBC, Ua)	55.380	54.430	52.750

Figure 4.4 - Means of overall accuracy for each format in the order they were presented to each group



Word Identification Accuracy

A repeated measures ANOVA was conducted with the within subjects factor being format and the dependent variable being word identification accuracy. A score comprised of the number of correctly identified words was measured by points (out of 30 points total). The means and standard deviations for word identification accuracy are presented in table 4.7 below. The result of the ANOVA showed no significant difference between word identification accuracy using the three formats presented, $F(2,50) = 1.567$, $p = .219$, $\eta^2 = .059$.

Table 4.7 – Estimated means and standard deviations for word identification accuracy

	CBC	U_a	U_b	Marginal B/N Subjects Means
Group A	Probe 1	Probe 2	Probe 3	
	μ = 25.000	μ = 21.400	μ = 25.200	μ = 23.867
	SD = 3.197	SD = 7.137	SD = 4.541	SD = 1.222
Group B	Probe 3	Probe 1	Probe 2	
	μ = 27.000	μ = 27.000	μ = 23.100	μ = 25.700
	SD = 2.309	SD = 3.162	SD = 6.367	SD = 1.222
Group C	Probe 2	Probe 3	Probe 1	
	μ = 26.880	μ = 25.750	μ = 27.750	μ = 26.792
	SD = 2.475	SD = 6.944	SD = 2.816	SD = 1.366
Marginal W/N	μ = 26.25	μ = 24.640	μ = 25.180	
subjects Means	SD = 2.711	SD = 6.255	SD = 5.099	

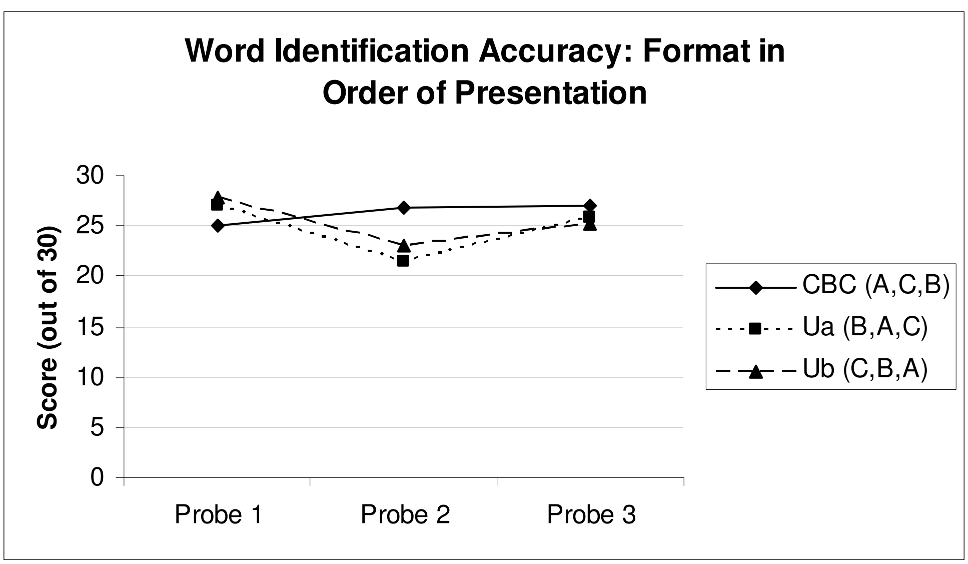
μ = Estimated Means; SD = Standard Deviation

The interaction of word identification accuracy and order was significant, $F(4,50) = 3.861$, $p = .008$, $\eta^2 = .236$. This interaction was not explainable by pair-wise comparisons, as no contrasts were significant. However, table 4.8 and figure 4.5 show the interaction of order by group and order by format. The interaction may be explained by probe two having slightly lower mean scores than the tests of the same format for probes one and three (i.e. mean scores for U_a on probes one and three were slightly lower than on probe two; the same occurred for U_b).

Table 4.8– Word identification accuracy - shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
CBC (A,C,B)	25.000	26.880	27.000
Ua (B,A,C)	27.000	21.400	25.750
Ub (C,B,A)	27.750	23.100	25.200

Figure 4.5 – Means of word identification accuracy for each format in order that each was presented

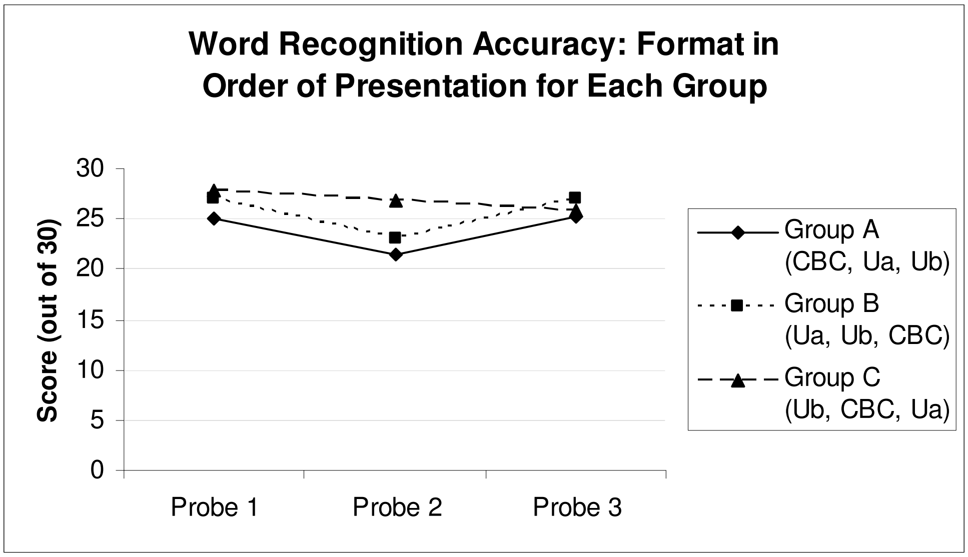


A between subjects analysis indicated that order did not have an effect, $F(2,25) = 1.335$, $p = .281$, $\eta^2 = .096$. Again, confirming that order and difficulty of passages were not significant variables (see table 4.9 and figure 4.6).

Table 4.9 – Between subjects' means for word identification accuracy - shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
Group A (CBC, Ua, Ub)	25.000	21.400	25.200
Group B (Ua, Ub, CBC)	27.000	23.100	27.000
Group C (Ub, CBC, Ua)	27.750	26.880	25.750

Figure 4.6 – Means of word identification accuracy for each format in the order they were presented to each group



Typeset Identification Accuracy

A repeated measures ANOVA was conducted with the within subject factor being format and the dependent variable being typeset identification accuracy, a score comprised of the number of correctly identified typesets, as measured in points (out of 30 points total). The means and standard deviations for typeset identification accuracy are presented in table 4.10 below. The ANOVA showed no significant differences between typeset identification accuracy using the three formats presented, $F(2,50) = 0.820$, $p = .446$, $\eta^2 = .032$. The interaction of typeset identification accuracy and order was not significant, $F(4,50) = 0.378$, $p = .823$, $\eta^2 = .029$, and order did not have an effect, $F(2,25) = 0.850$, $p = .439$, $\eta^2 = .064$ (see table 4.11 for means).

Table 4.10 – Estimated means and standard deviations for typeset identification accuracy

	CBC	U_a	U_b	Marginal B/N Subjects Means
Group A	Probe 1	Probe 2	Probe 3	
	μ = 27.600	μ = 26.800	μ = 27.900	μ = 51.267
	SD = 2.119	SD = 3.736	SD = 2.370	SD = 2.064
Group B	Probe 3	Probe 1	Probe 2	
	μ = 26.400	μ = 24.800	μ = 24.600	μ = 51.067
	SD = 3.534	SD = 8.351	SD = 7.975	SD = 2.064
Group C	Probe 2	Probe 3	Probe 1	
	μ = 27.620	μ = 27.000	μ = 27.620	μ = 54.208
	SD = 3.583	SD = 3.207	SD = 2.925	SD = 2.308
Marginal W/N	μ = 27.180	μ = 26.140	μ = 26.640	
subjects Means	SD = 3.056	SD = 5.622	SD = 5.265	

μ = Estimated Means; SD = Standard Deviation

Table 4.11– Formats presented by typeset identification accuracy across probes- shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
CBC (A,C,B)	27.6	27.62	26.4
Ua (B,A,C)	24.8	26.8	27
Ub (C,B,A)	27.62	24.6	27.9

Figure 4.7– Means of typeset identification accuracy for each format in the order that each was presented

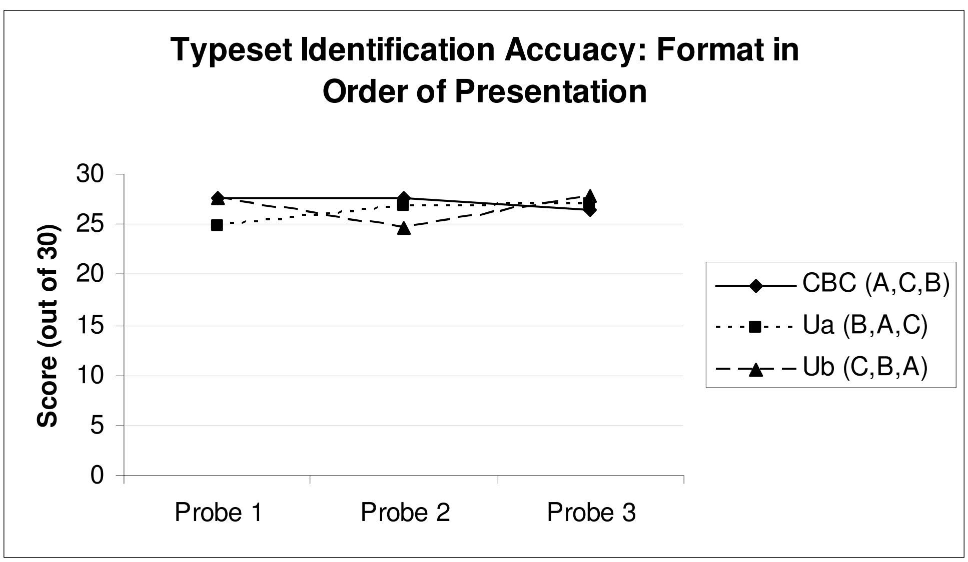
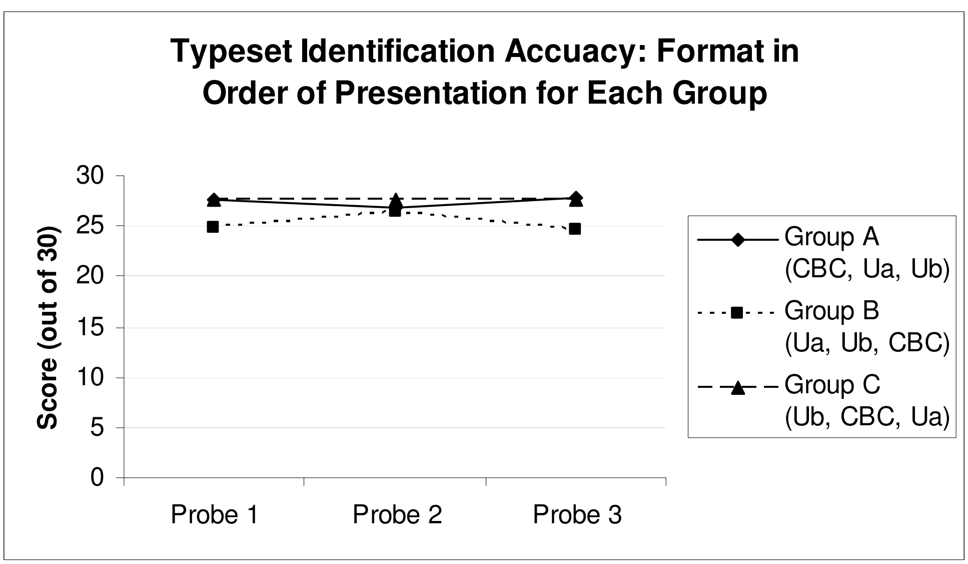


Table 4.12– Between subjects' means for typeset identification accuracy - shown in the order they were presented for each format

Format (order of groupings)	Probe 1	Probe 2	Probe 3
Group A (CBC, Ua, Ub)	27.6	26.8	27.9
Group B (Ua, Ub, CBC)	24.8	26.4	24.6
Group C (Ub, CBC, Ua)	27.62	27.62	27.62

Figure 4.8 – Means of typeset identification accuracy for each format in the order they were presented to each group



Correlational Analysis

Correlation coefficients were calculated to determine if a relationship existed between overall accuracy and speed. The Bonferroni approach was used to control for Type I error, and a *p* value of less than .01 (2-tailed) was required for significance. The results of the correlational analysis are presented in table 4.13 below. Four of the correlations performed were statistically significant. Accuracy on each of the tests correlated with accuracy on the other tests (i.e. accuracy on CBC correlated with accuracy on U_a; accuracy on U_a correlated with accuracy on U_b; and accuracy on U_b correlated with accuracy on CBC). Likewise, speed on each of the tests correlated with speed on other tests (i.e. speed using CBC correlated with speed using U_a; speed using U_a correlated with speed using U_b; and speed using U_b correlated speed using on CBC). Interestingly, speed using U_a was negatively correlated with accuracy using U_a ($p = .009$), meaning that the longer students took on the test, the lower they scored on accuracy.

Table 4.13 - Correlation coefficients for overall accuracy and speed

	Accuracy			Speed		
	CBC	Ua	Ub	CBC	Ua	Ub
Accuracy CBC						
Accuracy U_a	.600*					
	$p = .001$					
Accuracy U_b	.384*	.587*				
	$p = .040$	$p = .001$				

Speed CBC	-.238	-.259	-.051		
	p = .214	*p* = .184	*P* = .794		
Speed U_a	-.131	-.485*	-.363	.696*	
	p = .506	*p* = .009	*P* = .058	*p* = .000	
Speed U_b	-.210	-.367	-.289	.622*	.749*
	p = .273	*p* = .055	*P* = .128	*p* = .000	*p* = .000

Overall Accuracy = Word Identification Accuracy and Typeset Identification Accuracy (out of 60)

$p < 0.01$ (2-tailed) for significance

Correlation coefficients also were calculated to determine if a relationship existed between word identification accuracy and typeset identification accuracy (see table 4.14). A significant correlation existed between word identification accuracy on U_a and U_b. A significant correlation also existed between word identification accuracy and typeset identification accuracy using CBC. This significance was explained as students who scored high on word identification accuracy when using CBC also scored high on typeset identification. Conversely, students who scored low on word identification accuracy when using CBC also scored low on typeset identification. Similarly, a significant correlation was found between word identification accuracy and typeset identification accuracy using U_b.

Table 4.14 – Correlation coefficients for word identification accuracy and typeset identification accuracy

	Word Identification Accuracy			Typeset Identification		
	CBC	Ua	Ub	CBC	Ua	Ub
Word Identification Accuracy U_a	.651* $p = .000$					
Word Identification Accuracy U_b	.350 $p = .063$	.478* $p = .010$				
Typeset Identification Accuracy CBC	.487* $p = .007$	.188 $p = .339$	.117 $p = .544$			
Typeset Identification Speed U_a	.064 $p = .746$	.264 $p = .175$	.190 $p = .332$	.630* $p = .000$		
Typeset Identification Speed U_b	.021 $p = .913$	.126 $p = .521$	.373* $p = .047$	.583* $p = .001$	.766* $p = .000$	

$p < 0.01$ (2-tailed) for significance

Qualitative Results

Pre-Instruction Interview

Results of the Pre-Instruction interview showed that 19 students (out of 28) had seen words written in italics, bold, underline, or color, prior to the study (see table 4.15).

However, only 13 students articulated that the composition sign (dots 4,6) was used to indicate italics, bold, and underline. Five students said they had never seen them, and four students said they weren't sure if they had seen them. One student said he had never seen words in italics, bold, or underline, but he knew the braille composition sign, dots 4 and 6, was used for these words.

Table 4.15 – Number of students having prior experience with typesets

Have you ever seen words in your book that are italicized, underlined, or bold?	
Yes	19
No	5
I don't know	4

The majority of the students (n = 22) were not able to describe what these features would look like in print. In fact, only one student knew that italicized words were slanted; one student knew that bold words were darker; and three students said that underlining meant that the words had a line underneath them. Comments from students are summarized in table 4.16. Some students were cognizant that typeset features altered words, and attempted to describe the changes. Four students said that italicized, bold, and underline meant that the words were bigger; one student said that bold words were "blobs"; and one student said that words in color meant that it was written in pencil or red.

Table 4.16- Comments demonstrating knowledge of visual attributes of print

Concept of print (# of statements)	Comment
Italics (1)	"The print is maybe slanted?"
Bold (1)	"It means that it is in dark letters."
Underlining (3)	"Like in print, an underlined word means that it's a word with a line under it, right?" "I know what an underlined word looks like in print… it's a word with a line under the whole word…" "Because in print, sometimes they underline it (the word)."
Color (1)	"…colored words mean its… written with pencil, or like its red."
Size of print (4)	"Because it (print) can be small or big letters." "Because they (authors or textbooks) want it in bigger print." "Only big print." "They're in big letters"
Description of alteration to print (6)	"That it's fancy writing." "Like in print, what color (words look like)? It looks like white with something green in front of it, and in yellow and on the side of it has something yellow… I see it." "my assistant told me that to look for the words, and I couldn't

> find it, because it looks like, a little closer to the braille… the dots are close to the braille… like you could read them, but like you don't know what they are."
>
> "Um, I think they look like little blobs."
>
> "If you're doing italicized… what is italicized? So, I can maybe get an idea." (teacher replies – "Well, in print it slants that letter slightly, to one side, it tilts it.") "Oh, so maybe it would be like a diagonal line in print."
>
> "Can it look like a line that goes like (pointing to paper)… or it looks like… or like it's in front of it like, you go… right there or right there?"

Responses gathered from the interviews were telling of the students' understanding of printed materials and the function of typesets. One question was, "Why do you think print books make some words different?" Only five students seemed to understand that visual attributes were used for a purpose. Statements indicating the purpose of typeset included, "to draw attention," "they're special," "they're spelled differently," "adds to print," and "important words" (see table 4.17). Eleven students replied that they didn't know why print books would have words written differently.

Table 4.17 – Students' Responses – Illustrating purpose of typesets

Comments demonstrating understanding of the purpose of visual attributes of words such as typeset	"…to draw your attention" "Because it can add to the print" "Because they're special words" They're (words in bold) spelled differently" "Well, the special words I think are underlined… I don't know about colored or bolded, but I think the special words are underlined…. Well because they (underlined words) may show them (print readers) that its an important word."

Some responses were random or did not address any of the interview questions. These responses provided insightful information about students' perceptions and concepts of print. Many children clearly knew that print was something that was seen visually, and they were keen on pointing out that braille was read with their fingers. Other students commented that contracted braille was different than print words. Some students had random comments that illustrated a lack of understanding of print concepts. Statements illustrating students' perceptions of the differences between print and braille are summarized in table 4.18 below.

Table 4.18 – Students' responses – Illustrating concepts of print

Comments demonstrating knowledge of differences between tactile materials and printed materials	"Because you can't feel them (print words), you look at them with your eyes." "You can't feel it if its not raised on something. Especially on paper you can't even feel it." "They're (print words) not so bumpy as braille." "They're (print words) different, you don't feel them, you can't feel them easily." "I don't see print, I see raised dots." "They're (print words) probably made differently… they're written in the print instead of braille." "Well, because they don't have dots on them."
Comments demonstrating knowledge of differences between print and braille related to braille contractions or spelling	"Because theirs's (print readers) uncontracted, its uncontracted in the print books, and in the braille books there's contractions and sometimes its uncontracted" "Well because the words in your guyzes books (print readers) are not the same as in mine, because… they're spelled differently." "Because they're longer (print words) than braille words, cause some (braille words) have contractions."
Random statements	"Because there's some letters in print, like an R, it's hot, like,

	maybe it fell down, and then like, in braille it's just like a cross." "Maybe their (print readers') words are wrong and so they have to symbol it." "(words are underlined) Because they want to trick you." "I don't know (what print letters look like), cause it's in print, and I don't really read in print."

Question four was, "Do you think that finding the words that are different is important?" 21 of the 24 students who responded to this question indicated that "yes" finding these words was important. However, when asked question five, "What do you do when you find these words?" several students did not respond to the braille symbols as if they were important. These students said they didn't know what to do (n = 8); they skipped the over the words (n = 4); or they did nothing when they found these words (n = 2). Respondents who took notice of words that had typeset the markings would read them out loud (n = 7), sound them out or check the spelling (n = 5), mark or write them down (n =3), ask someone for help with the words (n = 1), or pay attention to them (n = 1). Responses are summarized in table 4.19 below.

Table 4.19 – Students' responses regarding the importance of typeset indicators

Students who didn't respond	Didn't know what to do	8
to the symbols as if they	Skipped over the words	4

were important	Did nothing	2
Students who responded to the symbols as if they were important	Read the words out loud	7
	Sounded out the words	5
	Marked or wrote down the words	3
	Asked someone for help	1
	Paid attention to them	1

Post-Instruction Interview

The main purpose of the post-instruction interview was to determine if the students had a preference for one of the formats that was used in presenting typesets (CBC, U_a, or U_b). Half (n = 14 of 28) of the students preferred one of the two new formats. Of the 14 students that preferred U_a or U_b, 10 stated that having the typeset indicator before the underline ($U_{b)}$ was easier to read. Nine students indicated that they preferred CBC, and five students said they did not have a preference or did not know which one they preferred.

Further analysis of pre-interview and post-interview data showed that 10 of the 13 students who had prior knowledge of braille compositions symbols for bold, italics, and underline, preferred U_b over CBC (8 of whom preferred U_b, two of whom preferred U_a, and one student who remained undecided). Only 2 of the 13 participants who had prior knowledge of emphasis indicators preferred the CBC after the study was completed.

When preference was analyzed with speed, none of the nine respondents who preferred the CBC were faster using it than U_a or U_b (see table 4.20). However, students who preferred U_a or U_b, did not necessarily perform faster on their preferred format. Two of the four students who preferred U_a did best on U_b. Similarly, 2 of the 11 students who preferred U_b did best on CBC, and 4 students who preferred U_b did best on U_a.

When students' speeds were averaged across the three probes and compared with their stated preferences, most children who preferred U_b were slower at the task, than students who preferred U_a or CBC (see table 4.20). In fact, 7 of the students who preferred U_b were among the 9 slowest performers. In contrast, the 3 students who preferred U_a were among the top 4 fastest students. Interestingly, the students who remained undecided, or who did not give a preference were ranked in the middle of the sample.

Table 4.20 – Rank order of students' speed (in seconds) shown with students' preference

Rank	CBC (in sec.)	Ua (in sec.)	Ub (in sec.)	Average (in sec.)	Preference
1	228	92	121	147	Ua
2	241	130	96	155.667	CBC
3	223	196	153	190.667	Ua
4	270	194	135	199.667	Ua
5	216	216	206	212.667	Unknown
6	325	178	187	230	CBC
7	225	240	240	235	Ub
8	310	240	200	250	CBC

9	326	226	265	272.333	Ua
10	315	230	275	273.333	CBC
11	342	240	244	275.333	CBC
12	270	410	185	288.333	CBC
13	384	274	210	289.333	Ub
14	323	249	314	295.333	Ub
15	328	366	302	332	CBC
16	412	181	413	335.333	Unknown
17	440	282	350	357.333	Undecided
18	275	381	450	368.667	Undecided
19	467	290	366	374.333	Unknown
20	129	493	561	394.333	Ub
21	450	360	375	395	Ub
22	390	530	336	418.667	Ub
23	464	544	315	441	Ub
24	320	600	480	466.667	Ub
25	625	526	470	540.333	CBC
26	755	547	425	575.667	Ub
27	686	540	586	604	Ub
28	865	1017	552	811.333	CBC

The order that students completed the probes did not seem to have an effect on preference. Respondents from each of the three groups were equally spread between the preferred formats.

Questions four and five of the post-instruction interview were about how students thought of the words that had typeset features, and whether the formats that used the underlining changed how they might look at words. These were developed to inquire about thought processes when scanning for typesets. Question four was, “Did the exercises that you did change the way you might think about some words?” Eighteen students said “yes,” six said “no,” and two said they did not know or were undecided. Although the given interview questions did not include a follow-up, some teachers posed the follow-up question “how?” or “why?” Students’ responses to this question were categorized into (a) comments reflecting attributes of print, (b) comments reflecting purpose of typeset indicators (c) random statements. Table 4.21 is a summary of students’ comments.

Table 4.21 – Students’ responses – Illustrating effect of the exercises from the study

Comments reflecting attributes of print	“Yes, because I can tell the color of the words.” “Yes, because now I know what everything is in the books and stuff, and if they’re colored. I know if it’s blue, or red, or if its italicized. I know that the five six means italicized, because I could feel um.” “They make me think about the symbols in the word.”

	"Uh… yeah, I might think like that it's, it's like it's a different one… like blue, red, italics, it means that all of these words are italicized or whatever." "I could just only see the words with the dots 4-5-6 and the blue sign… I don't know, I think that it's important if its red." "Yeah… yes, it means that I can see the colors."
Comments reflecting purpose of typeset indicators	"Well they sort of help… say the important words, I thought would be in the passages." "Yeah, I guess. It changes it kinda changes it by saying, 'oh this word is kinda special'" "Yes, because they have underlines, or italics or things like that, that show you that you need to pay a lot of attention to them so you can… (pause) notice them." "Yeah, because, like, the… (pause), because when I see the underline or the thing in front of it, I can tell… (pause) that it's a special word. "
Random statements	"Yeah, scanning." "Cause, I don't know, it just changed." Yes, the uhhh, emphasizers helped me read "faster?"

Question five was, “Would you change the way you look at the story if you had the words underlined in U_a or U_b?” Fourteen students said that they would change the way they looked at the story, six said “no,” two said “maybe,” and four said they “didn’t know.” Comments were classified into categories indicating ease of use, and are included in table 4.22.

Table 4.22 – Students’ responses – Illustrating effect of the exercises from the study

Comments reflecting ease of use with U_a or U_b	“Not really, but it’s just easier to understand, kind of, when it’s at the beginning because I know which words are strong and I know which words aren’t very important. It’s easier to understand if it’s at the beginning, for me, but it might be different for other people.” “Yes, it would change it, like, cause if it’s before it would be harder to recognize, if it was after it would be easier to recognize… yes, cause the indicators, I know they’re the same, but they change places. They change spots, like here, then here. One before and one after, they change spots.” “Yes, it would change the way I look at stories, because… (pause) I would have to struggle less.”
Comments reflecting difficulty with U_a or U_b	“Yeah, maybe… um it probably changed the way I look at it by,. Say you have one story and it has it before, then you read a story with they symbol after it, it may confuse you a

	little… if you get used to one and then you move to the other, that could confuse you a little bit." "Yeah, because it (U_a or U_b) would be harder."
Random statements	"If it were the 4-6 sign it would be more longer." "Yes, it would because then I would be feeling it in a different kind of way, to know how it is." "Well, the italics sign where you just do the 4-6 and 4-5-6-r or 4-5-6-b that's the way I would change it so you underline…" "Yes… that they represent an underline." "It depends whether if I'm in a hurry to read it, like if its something that I have to, if its like a book club thing, or something like that." "Yes, I would scan across and up and down."

Summary of Results

Data collected and analyzed in the study successfully answered the research questions. The first research question was, "Do differences exist in the speed and/or accuracy of recognizing words presented in italics, red, or blue, using varying formats (CBC, U_a, U_b)?" A statistically significant difference was found in speed. Differences did not exist in accuracy. See table 5.1for a summary of the statistical analysis. The second research question was, "Do the students have a preference for how these indicators are transcribed into braille?" Based on student responses (n = 24), during the post-interview, half of the students interviewed preferred either U_a or U_b. Ten students preferred the indicator before the underline (U_b), four preferred the indicator after the underline (U_a), and nine students preferred the CBC.

Table 4.23 – Summary of Results for ANOVAs

Measurement	Significant Difference?	F(2,50)	p	η^2
Speed	Yes	3.196	0.049	0.113
Overall Accuracy	No	1.667	0.199	0.063
Word Identification Accuracy	No	1.567	0.219	0.059
Typeset Identification Accuracy	No	0.820	0.446	0.032

CHAPTER 5: DISCUSSION

The purpose of this study was to devise an alternate method of presenting typesets (i.e. bold, italics, and color) in braille, and investigate the use of the formats. Ultimately, the research was designed to determine if differences occurred in the speed at which readers were able to locate the words with emphasis, and if one way was easier to read for the participants. A secondary purpose was to examine students' perceptions and opinions about the current braille composition signs used in presenting format (CBC), versus two alternate formats that used an underline in an additional line spacing with the indicator either before the line (U_b) or after the line (U_a) (see appendix B). Results of the study showed that U_b was a preferred method of formatting as reported in student interviews, and students were faster at recognizing typesets within continuous text when using it, as compared with CBC or U_a. The accuracy of reading the words or identifying typesets was no different when the various formats were used.

Implications of this study

Several issues regarding composition symbols representing typeset in CBC were discussed in Chapter 1. The following discussion section is organized by these topics and results generated by the research, for each of these points, are discussed.

Accuracy: Recognizing Symbols Given the Innovative Visual Appeal of Print Materials

To recall, the influence of technology on printed materials has drastically changed how information is portrayed in children's textbooks. The author conducted a brief investigation of language arts textbooks used for second grade and found that books published in 2002 and 2006 had more visual appeal than books published in 1997. The examination of textbooks also revealed that scripted fonts, word art, sidebars, colored text boxes, pictures, and graphic images were some of the many examples that contributed to the motivating visual appeal for sighted learners. The complexity of visual aesthetics seen in textbooks has presented significant challenges for braille transcribers.

One innovative feature commonly used in printed materials is the multiple applications of colored words, font styling, and typeset attributes. Often, recognition of these features is essential to information gathering. They represent key words, vocabulary, spelling words, highlighted information, emphasis, etc. One criticism of CBC is that the symbol used to denote italics, bold, and underline is the same (dots 4,6 preceding the word). Therefore a reader would not be able to distinguish between these three attributes without assistance or without a key. BANA has recommended that a "Teacher's Reference Page" be included with teaching materials, and that a transcriber's note be written on the page, advising students to "Ask your teacher for help." Additional challenges of using CBC include transcription of four or more words in a row, transcription of more than one attribute in a sentence, or transcription of part of a word with an attribute. Special rules apply for the transcription of each of these scenarios, and students must be taught the rules and application of the rules to comprehend what is being conveyed in print.

The alternate formats of presenting typeset (U_a and U_b) distinguish between each bold, underline, and italics. With instruction, using the new formats, students would be more accurate and independent at determining the differences between bold, italic, and underline. Also, using the new format, multiple typeset indicators can be included in a line of text and be distinguishable from one another. Lastly, the new format could be adapted to easily transcribe parts of words without altering the shape of the word. Nonetheless, even the new format has limitations. First, only a finite number of letters can be used to denote changes to text (i.e. b can stand for blue, black, brown, or bold). Second, although additional configurations of the braille cell (that are not letters) can be used, even with the new system, students nonetheless must memorize what the symbol represents (i.e. *b* for blue and dots 4, 5, 6 for bold).

This study was designed to investigate the accuracy of identifying red, blue, and italicized words. Differences between bold and underlined words could not be tested because the CBC does not distinguish between these symbols. Results of an ANOVA with typeset identification accuracy as the dependent variable, showed no differences in accuracy of recognizing the typeset indicators between usage of CBC, Ua, or U_b. One explanation is that finding the indicator was a task that affected speed, but once the indicator was found, the students were able to determine what it represented without assistance and with relative ease. Therefore, accuracy was not a factor impacted by altering the presentation of formats.

Speed: Locating the Indicators within Continuous Text

Locating words with typeset indicators is not an equivalent task for a sighted reader versus a tactile reader. A sighted reader can glance at a page and immediately spot the word that is in bold print. Using the CBC, a tactile reader must scan each word of a passage in search of the typeset indicator. The process can be cumbersome. Also, composition symbols interrupt the flow of text for struggling readers who do not recognize them as composition signs.

Results of an ANOVA with speed as the dependent variable showed that students were faster using U_b as compared with CBC or U_a. In interviews, many students also reported that U_b was easier for them to use. The additional line break underneath the word with a typeset indicator before the words, in U_a and U_b, were designed to assist readers in the scanning process. Using U_a or U_b students could be taught to scan the text using a vertical hand motion, thus rapidly locating the line break. Once the line break is located, then the student could scan horizontally and find the indicator and word. For the task in this experiment this technique could not be applied because several emphasis indicators were located in the passage, sometimes on the same line; thus making the page overly cluttered and the task more difficult. Nevertheless, students performed the task faster when U_b was used, in comparison to CBC or U_a.

Interestingly, when mean speeds across all three probes were compared with preference, students who preferred CBC were faster at the task, and the slower students preferred U_b. One explanation for this could be related to reading ability. Students who were able to do the task quickly also may be faster readers. The symbols of the CBC may not be interfering with their ability to recognize the indicator and decode the word. On the other hand, for students who are less proficient readers, the task of scanning and locating the symbols in CBC may be more difficult.

Interference with Reading Fluency

Typically reading fluency scores are calculated as the number of correctly read words minus the words read incorrectly divided by the time that it takes for a student to read the passage; thus yielding *words per minute (WPM)*. In this study, reading fluency was not calculated by WPM. However conclusions can be drawn from the data that relate to reading fluency.

First, one component of reading fluency is the ability to read words correctly. As discussed previously in Chapter 1 of the dissertation, the CBC uses symbols that easily can be confused with letters and potentially interfere with decoding. BANA states, "The inclusion of emphasis symbols (italics, bold, underlining) is still under research. It is particularly important when first learning to read that the shape or 'look' of a word remain consistent. To precede a word with a braille emphasis indicator changes the 'shape' of the word, making the word less familiar and recognizable. (ATIC & BANA, 2007, Emphasis or Typeset Indicators, para. 1)"

The proposed alternate formats of presenting typeset investigated in this dissertation were designed to eliminate the confusion presented when the shape of a word is changed. Thus, using the new formats, the typeset indicators would not interfere with decoding. Results from the study showed no statistically significant difference in the children's ability to read words using the CBC, U_a or U_b. Although an interaction effect was found between the order in which students were given the tests and the various formats, pair-wise comparisons showed no effect. Results also were obtained regarding the overall accuracy of identifying words and typesets. No statistically significant differences occurred in overall accuracy between the students' use of one format over the other.

A second component of reading fluency is speed. Although the measures taken in this study did not account for the time spent reading a passage, implications from the measurements of speed relate to reading fluency. One theory is that composition symbols used in CBC interfere with the shape of a word, thus making the symbol difficult to identify and the word difficult to decode (ATIC & BANA, 2007). However, if the student is able to recognize the symbol quickly, then the time that it takes for a student to recognize the typeset indicator sign would be reduced, consequently speeding the process of reading. In other words, students will no longer waste time figuring out what the symbol is, and they will be faster readers. According to the National Reading Panel, reading fluency is a "critical factor (National Reading Panel, n.d. What is Reading Fluency section, para 1)" in reading success. They contend that reading fluency is related to reading comprehension. Therefore, if an alternate form of presenting typeset indicators increases reading fluency, then reading comprehension also may improve.

As stated earlier, students who preferred U_b were slower at the task than the students who preferred CBC. One explanation for this could be related to reading fluency. The most common reason students preferred U_b was because it was easier. The task of finding the words may have been easier than using CBC. Also, the task of reading the words aloud may have been easier because the composition signs did not change the shape of the word. Despite preference for CBC, students who stated CBC was easier performed faster on U_a or U_b. One reason students may have preferred CBC was because these students were deliberate readers. They were not able to scan the text without reading every word in the text.

Issues Related to Scanning

Interestingly, teachers reported they had never taught their students to *scan*. Some students had a difficult time not reading every word of the passage. One student dropped the study because the task of scanning and reading only words with typesets was too difficult for her. An important question emerged, “Should we teach children to scan text?” By using scanning skills the reader quickly gathers important contextual information that can lead to better comprehension.

Sighted individuals often glance at text for rapid information gathering and context. For example, an invitation, outline, business letter, or essay can be presented to a sighted reader and he/she would immediately recognize the genre of text. Similarly, words presented in bold or italics are emphasized for the sighted reader for immediate recognition. The task of scanning and locating the words with emphasis happens almost instantaneously. To create a similar task for a tactile reader, the presentation of words with emphasis must change, which is what the author of this dissertation has proposed. Then, teachers must teach their students to scan and locate words with emphasis.

The skill of scanning and locating words that are emphasized is essential for learning. Typesets are used to emphasize words that are important. Without being able to recognize these words, students lose the opportunity to focus on them. When words are deemphasized, the magnitude of importance also is lost. Additionally, emphasis of words helps with reading comprehension and vocabulary development. One way to develop vocabulary is to reinforce the use of the word in functional and meaningful tasks, reading the words in a story or sentence, for example. Accentuating vocabulary words assists in vocabulary development, but students who are not able to locate the words may not realize they are new words. Likewise, students who come across the typeset indicator, but are not familiar with the symbol overlook the word's emphasis. Equal access to the text requires indicators that are easily and rapidly identified. The proposed format (U_b) has proven to be a faster method for readers to locate and identify typeset indicators.

Conceptual Development – Vocabulary

Nevertheless, despite rapid recognition of words with emphasis, students must be instructed on the purposes of typeset. Results from the pre-instruction interview showed that students did not have conceptual understanding of print or the purposes for emphasizing print words. While students knew that the 4,6 symbol meant that a word was italicized, or underlined, they were not able to explain why that was important, or what it looked like. Therefore, the task of scanning and locating these words was not familiar or functional to them. The following dialog illustrates a student who is trying to understand what words in italics would look like.

Student: What is italicized, so I can maybe get an idea?

Teacher: Well, in print it slants that letter slightly, to one side, it tilts it.

Student: Oh, so maybe it would be like a diagonal line in print.

Teacher: Well, why might they do something in italics?

Student: Uh…

Teacher: So italics are tilted to the side, do you know why?

Student: They're tilted to the side?

In addition to the conceptual understanding and vocabulary for visual attributes of text, students must also understand the purpose for emphasizing words. Pre and post-instruction interviews showed that students did not know why words would be put into italics, bold, or underlined. They indicated that these words were important, but did not articulate strategies that reinforced the importance of the words. The lack of attention to key words may contribute to lack of depth in vocabulary development.

One implication that emerged from the results was that students must be deliberately taught concepts of print and vocabulary that are used to describe font styling, color, format, typeset, and other visual aspects of printed materials. The understanding is essential for a variety of reasons. First, students must be able to converse with teachers and peers who read print. They must have the vocabulary to explain visual attributes, and they must be able to ask appropriate questions related to print materials. Second, students often are asked to perform tasks related to the words with emphasis. For example, students may be asked to copy words in bold from their text. Third, when reading stories, words with emphasis are significant to the meaning of the story, or the pragmatics (inflection). Ultimately, competence in these tasks is necessary for equal access to print materials and for participation in the general education curriculum.

Limitations

Despite a national search, only 30 participants were recruited for the study. While the sample size was small, it was fairly representative of the population. According to the American Printing House's Federal Quota Registry for the year 2005, only 617 students were reported as being 2nd and 3rd grade braille readers (APH, 2006a); a number slightly higher than the years 2004 (n = 513) (APH, 2006b) and 2003 (n = 502) (APH, 2003). The selection criteria also reduced the pool of participants, as many children ages 7-9 are not reading single spaced, contracted braille above a first grade level. Although several teachers responded to the solicitation for participants, their students did not meet selection criteria.

Many limitations of this study related to the pre and post-instruction interviews. The first noted limitation was that the concepts and vocabulary in interview questions may have been too difficult for the children to understand. Words such as italics, bold, and typeset may not have been familiar terms for the students. Likewise, the concepts they were being questioned about were abstract and perhaps above the analytical reasoning abilities of young 7 to 9 year old children. For example, one question was, “Did the exercises that you did change the way that you might look at text?” This question required reflection on all three formats and analysis of the processes used when completing the task for each of the formats. Perhaps this question was too abstract.

One limitation of the interviews was that students were not able to answer all of the questions without an understanding of print concepts. This was both a strength and a limitation. Although the purpose of many interview questions was to gain insight into the students’ prior knowledge and understanding of print, some students were not able to answer all of the questions appropriately. For example, if the student said that he had never seen words in bold, italic or underlined , in the pre-instruction interview, then he was not able to answer the next question, “Can you describe what typeset changes may look like in print.” Also, the post-instruction interview questions 4 and 5 were worded poorly, and they should have asked *why* or *how*.

The unfamiliarity with the task of finding words with typeset, and the difficulty in scanning may have been a limitation. Students were being asked to do something TVI had never asked them to do before. One student had to drop out of the study because the task was too difficult. Several other TVI mentioned after they finished that this was not something they’d ever done with the students. Four teachers said that their student never really scanned, they continued to read the text deliberately. Students’ preference for one of the formats over the other may have been influenced by the need to deliberately read the text. Students who preferred CBC, for example, may have in actuality been reading the stories for meaning, and not skimming the text to locate words with typeset features. Students who were unfamiliar with the task may not have understood the purpose of locating words with typeset indicators. Because it was not a functional activity to them, they may not have had optimal performance.

The most significant limitation was the bias of teachers during interviews. Although most interviews were conducted without bias, a few teachers may have influenced their students’ responses by changing the inflection of their voice or asking leading follow-up questions. For example the following dialog occurred in one of the post-interviews.

Teacher – “Which way did you like better, the way you did it today (voice goes up)?”

Student – “Yes!”

Teacher – “Or the way you did it yesterday (voice goes down)”

Student – “No!”

Another instance of teacher bias is exemplified in the following dialog.

Teacher – “…which one was easier and which one did you like better?

Student – “I like the one with the line under it. What was it called again?”

Teacher – Okay, that’s the one that you liked, but was that easier to read?”

Student – “Yeah”

Teacher – “Or, was this kind easier to read?”

Student – “The kind with the line underneath it.”

Teacher – “I don’t think so! But, okay, you kept skipping those, because you couldn’t feel them, remember?”

Instances in which a child changed his/her response, only the first response was counted in the frequencies.

Future Research

The purpose of this study was to research the use of these indicators for elementary school children. The participant sample was limited to children ages 7-9 years old. Additional research with older participants would investigate the possibility of using similar coding for typesets in books written for older children and adults. Having adults participate in a similar study may yield different results because the task may be more familiar and functional to older readers.

Another possibility for extension is to apply this research to 8-dot braille and create similar formatting for words of emphasis. Eight-dot braille incorporates two additional dots, forming a 2x4 braille cell. Using 8-dot braille, a letter indicating the type of emphasis would be written in the lower portion of the cell and dots 7,8 would be used to underline the word, see figure 5.1.

Figure 5.1 - Example of 6-dot and 8-dot braille for the word “bird” in red

6-dot current braille code

```
O● ●O     ●O O● ●O ●●     OO OO
O● ●●     ●O ●O ●● O●     OO OO
O● ●O     OO OO ●O OO     O● ●O
```

Proposed U_b:

```
OO ●O O● ●O ●●
OO ●O ●O ●● O●
OO OO OO ●O OO
●O ●● ●● ●● ●●
●● OO OO OO OO
●O OO OO OO OO
```

8-dot braille:

```
OO ●O O● ●O ●●
●O ●O ●O ●● O●
●● OO OO ●O OO
●O ●● ●● ●● ●●
```

Conceptually, transitioning from U_b to 8-dot braille would be relatively simple because the symbols from U_b would be retained (i.e. i for italics, b for bold, r for red, etc.). Although the additional dots may initially impact reading fluency, progression into using 8-dot braille can start at an elementary age with the proposed format U_b, then progress into 8-dot braille. Proper training and practice would assist students in identifying emphasis indicators and transitioning into 8-dot braille. Eventually, evolution into 8-dot braille would lead to reading words with emphasis on a refreshable braille display. This research study could be replicated to determine if speed and accuracy are impacted by using 8-dot braille, and if readers prefer it to the CBC.

Advantages of 8-dot braille include immediate recognition of words with emphasis and potential saving space in braille transcription. The additional spacing created by dots 7,8 would be easily distinguishable by touch and quickly recognizable for a proficient braille reader. A reader could scan the page in search of the line-spacing change (similar to scanning techniques used when using U_b) and immediately be able to locate the word with emphasis on the page. Lastly, the use of 8-dot braille in hard copy transcriptions of braille would impact space, in that words written in color would have the indicator attached to them (unlike CBC) and an additional line spacing would not be necessary (unlike U_b). Disadvantages of employing 8-dot braille formatting include difficulty producing materials without an embosser with 8-dot capability and inability to use a Perkins braille writer to create materials.

Conclusion

The current method of presenting typeset indicators, using the CBC, was investigated in this study. Two alternate formats were also proposed and compared against the CBC on speed, accuracy, and students' preference. The project, supported by BANA, was designed to provide significant data to support necessary changes to the current braille format and symbols used for words with emphasis.

Based on the research, the author concludes that using U_b to present typesets is easier to recognize and readers can locate words with emphasis faster. The author recommends that U_b be adopted for use in early elementary textbooks to indicate typeset features of words. The task of identifying the symbols quickly was faster when U_b was used, as compared to U_a or CBC. In contrast to CBC, the use of U_b does not interfere with the shape of a word or the flow of text. Therefore, for struggling readers, reading words in U_b is an easier task than reading words in CBC. Although the new format will not add to aesthetic appeal of tactile words, it will differentiate between typesets and make them easier to locate, resulting in faster recognition of key words. The proposed format also would provide more discriminate symbols, to differentiate between bold, underline, italics.

Additionally, the author recommends that teachers teach the concepts of print related to visual attributes of text. Children should be familiar with the language used to describe font styling, typeset emphasis, and other visual features of printed materials. Lastly, teachers must teach students the purposes behind emphasizing certain words. Tasks involving words of emphasis should be transcribed with scaffolding until the student is able to complete tasks involving words with emphasis independently.

APPENDIX A - IRB APPROVAL LETTER

THE UNIVERSITY OF ARIZONA.

Human Subjects
Protection Program

1255 N. Mountain Ave.
P.O. Box 245137
Tucson, AZ 85724-5137
Tel: (520) 626-6721
http://irb.arizona.edu

June 9, 2007

Cheryl Kamei Hannan
Advisor: Jane Erin, PhD
Dept. of SERSP
P.O. Box 210069

BSC: B07.206 CREATIVE TYPESET REQUIRES INNOVATIVE SOLUTIONS

Dear Ms. Hannan:

We received your research proposal as cited above. The procedures to be followed in this study pose no more than minimal risk to participating subjects and have been reviewed by the Institutional Review Board (IRB) through an Expedited Review procedure as cited in the regulations issued by the U.S. Department of Health and Human Services [45 CFR Part 46.110(b)(1)] based on their inclusion under *research categories 6 and 7*. As this is not a treatment intervention study, the IRB has waived the statement of Alternative Treatments in the consent form as allowed by 45 CFR 46.116(d)(2). Although full Committee review is not required, notification of the project is submitted to the Committee for their endorsement and/or comment, if any, after administrative approval is granted. This project is approved with an **expiration date of 9 June 2008**. Please make copies of the attached IRB stamped consent documents to consent your subjects.

The Institutional Review Board (IRB) of the University of Arizona has a current ***Federalwide Assurance*** of compliance, ***FWA00004218***, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made to the procedures followed without the knowledge and approval of the Human Subjects Committee (IRB) and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Theodore J. Glattke

Theodore J. Glattke, Ph.D.
Chair, Social and Behavioral Sciences Human Subjects Committee

TJG/rf
cc: Departmental/College Review Committee

Arizona's First University – Since 1885.

APPENDIX B – EXAMPLES OF FONT INDICATORS

	One-Cell Whole Word Contraction or single words	**Single Word**	**Multiple Words (< 4 words indicated)**
CBC			
Italics	I would *like* an apple.	The fox *jumped*.	See the *brown dog*.
Bold	See **the** black cat.	John is **happy**.	He is a **very nice cat.**
Underline	I can do it!	I like soda for lunch.	I can learn braille.
Red Font	I like that fat cat.	The mouse is quick!	May I have more peas?
Blue Font	He will see her.	I will not go home.	People do not want it.

U_a			
Italics	I would *like* an apple.	The fox *jumped*.	See the *brown dog*.
Bold	See **the** black cat.	John is **happy**.	He is a **very nice cat.**
Underline	I can do it!	I like soda for lunch.	I can learn braille.
Red Font	I like that fat cat.	The mouse is quick!	May I have more peas?
Blue Font	He will see her.	I will not go home.	People do not want it.

$\mathbf{U_b}$			
Italics	I would *like* an apple.	The fox *jumped*.	See the *brown dog*.
Bold	See **the** black cat.	John is **happy**.	He is a **very nice cat.**
Underline	I can do it!	I like soda for lunch.	I can learn braille.
Red Font	I like that fat cat.	The mouse is quick!	May I have more peas?
Blue Font	He will see her.	I will not go home.	People do not want it.

APPENDIX C – SOLICITATION OF PARTICIPANTS

Solicitation of Participants: To be posted on Internet List Serves for teachers and educators of the visually impaired

Project Title: Creative Typeset Requires Innovative Solutions
Cheryl Kamei Hannan, Doctoral Candidate, University of Arizona (520) 891-6665 or cherylkamei@hotmail.com for more information.

I am a doctoral student at the University of Arizona and a the Program Coordinator for the Credential Program in Visual Impairments at CA State University, Los Angeles. I am looking for students ages 7-9 years old who read braille as their primary reading medium at a first grade level or higher using single spaced braille. I would like to invite you to be a participant with your student in a research project being sponsored by the Braille Authority of North America (BANA). For participating **you could earn up to $100.00 and your student will earn $25.00** for completing the study.

The project will involve teaching your students the braille symbols used for bold/italic/underline and for colored words. Two alternate forms of presenting these typeset features will also be introduced. The students will be asked to learn the symbols and take a test that will measure their speed and accuracy at finding the words with typeset features.

I am looking for about 30 children and their teachers to participate. Each session will take no longer than 45 minutes and the entire study may take three or four sessions, but we will finish the project by February even if not all of the tests are completed. However, compensation will only be given to students and teachers that complete the 3 tests. Students also will be asked some questions about finding the words with the special symbols. An audio recording will be made of their answers, so that I can evaluate the responses later.

This research could potentially affect how typeset is written in braille code. Also any new information discovered about the research will be provided to you as a participant. Eventually, the information may be published in a professional journal or report.

If you are interested, and you have a student who is 7-9 years of age and reads braille at a first grade level or higher, **please contact Cheryl Kamei Hannan, Doctoral Candidate, University of Arizona (520) 891-6665 or cherylkamei@hotmail.com for more information.**

APPENDIX D – IRB APPROVED PARENTAL CONSENT FORM

PARENT/LEGAL GUARDIAN CONSENT FORM

Project Title: *Creative Typeset Requires Innovative Solutions*

You are being asked to read the following material to ensure that you are informed of the nature of this research study and of how your child will participate in it, if you consent for him/her to do so. Signing this form will indicate that you have been so informed and that you give your consent. Federal regulations require written informed consent prior to participation in this research study so that you can know the nature and risks of your child's participation and can allow him/her to participate or not participate in a free and informed manner.

PURPOSE
Your child is being invited to participate voluntarily in the above-titled research project. The purpose of this project is to research how typesets (words that are written in bold, italic, or color) are best written in braille, so that the reader can find the words quickly and accurately.

SELECTION CRITERIA
To be eligible to participate, your child must be between 7 and 9 years of age and must read braille. Up to a total of 30 individuals from several states will be enrolled in this study.

PROCEDURE(S)
The following information describes your child's participation in this study which will last up to 45 minutes per session for three or four days:

- Your child will be introduced to the braille symbols used to indicate that a typeset change has occurred in the printed text. He/she will learn the symbols and then take a short test to see how fast he/she can find the symbol and tell the researcher which words have the typeset change.
- Two other tactile symbols will be introduced as alternative methods of presenting the typeset change. He/she will learn the alternative symbol and take tow other timed tests.
- Each session will not last more than 45 minutes. The sessions may be spread out over several weeks, but will not continue past February. Sessions will occur during the school day or after school.
- Your child will also be interviewed during the first and last session about what typesets are and about which symbols he/she prefers. The interviews will be audio-taped and later transcribed for the researcher to evaluate.

RISKS
There are no identifiable risks involved with this study. The student will be learning Braille symbols and completing tactile discrimination exercises that are appropriate for a child age 7-9 years old.

BENEFITS
The benefit is that you child will learn these symbols and it may help your child recognize the concepts of typeset. These typeset features are common on standardized tests, in textbooks, and in teacher made materials. The overall benefit is that results from this study could affect how braille symbols for typesets are written.

CONFIDENTIALITY
Your child's records will be confidential. They will not be identified in any reports or publications resulting from the study. Representatives of regulatory agencies (including the University of Arizona Human Subjects Protection program) may access the records.

The only persons who will know that your child participated in this study will be the research team members Cheryl Kamei Hannan, principal investigator and Doctoral Candidate, University of Arizona; Dr. Jane Erin, Faculty Advisor, University of Arizona; and your child's classroom teacher.

PARTICIPATION COSTS AND SUBJECT COMPENSATION
There is no cost to you or your child for participating except for the time. Your child will receive $25.00 for his/her participation ($5.00 for taking test 1, $10.00 for test 2, and $10.00 for test 3; totaling $25.00).

CONTACTS
You can obtain further information about the research or voice concerns or complaints about the research by calling the Principal Investigator Cheryl Kamei Hannan, M.A., Doctoral Candidate, & Principal Investigator at (520)891-6665. If you have questions concerning your rights as a research participant, have general questions, concerns or complaints or would like to give input about the research and can't reach the research team, or want to talk to someone other than the research team, you may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721. (If out of state use the toll-free number 1-866-278-1455.) If you would like to contact the Human Subjects Protection Program by email, please use the following email address http://www.irb.arizona.edu/suggestions.php.

AUTHORIZATION
Before giving my consent by signing this form, the methods, inconveniences, risks, and

benefits have been explained to me and my questions have been answered. I may ask questions at any time and I am free to withdraw my child from the project at any time without causing bad feelings or affecting his/her educational program. My child's participation in this project may be ended by the investigator or by the sponsor for reasons that would be explained. New information developed during the course of this study which may affect either my willingness or that of my child to continue in this research project will be given to me as it becomes available. This consent form will be filed in an area designated by the Human Subjects Committee with access restricted by the principal investigator, Cheryl Kamei Hannan, M.A., Doctoral Candidate, & Principal Investigator at (520)891-6665 **or authorized representative of the Special Education and Counseling Department at the University of Arizona. I do not give up any of my or my child's legal rights by signing this form. A copy of this signed consent form will be given to me.**

____
Subject's Name (printed)

Parent/Legal Guardian's Signature	Date
Witness (if necessary)	Date

INVESTIGATOR'S AFFIDAVIT:
Either I have or my agent has carefully explained to the parent/legal guardian of the subject the nature of the above project. I hereby certify that to the best of my knowledge the person who signed this consent form was informed of the nature, demands, benefits, and risks involved in his/her child's participation.

Signature of Presenter	Date
Signature of Investigator	Date

APPENDIX E – IRB APPROVED STUDENT ASSENT FORM

APPROVED BY UNIVERSITY OF AZ
THIS STAMP MUST APPEAR ON
DOCUMENTS USED TO CONSENT SUBJE
DATE: 6/9/07 EXPIRATION: 6/9/

MINOR'S ASSENT FORM

Title of Project: *Creative Typeset Requires Innovative Solutions*

Your mother/father has told me it was okay for you to participate in a research project that will hwlp me learn about how children who read Braille find words that are written in color, or that are written differently in print. We am trying to see if you can find these words quicker when they are in brailled in different ways. To find out if one way of brailling the words is better, I will teach you three ways that you may see the words. You will take three tests to see if one of these ways is faster. I will also be asking you several questions and audio-recording your answers, about the three ways of writing the words. If you decide that you want to participate, you will be paid $25.00 after you finish the three tests. Later, I will write about how you did on these tests.

☐ I give my permission for audio recordings to be made of me during my participation in this research study.

You do not have to be in this research study and you can stop at any time. If you decide that you don't want to participate your grade will not change, and your teacher will not think poorly of you. Do you have any questions? Is it OK?

____
Child's Name (Printed)

______________________________ _______________
Participant's Signature Date signed

Statement by person obtaining consent

I certify that I have explained the research study to the person who has agreed to participate, and that he or she has been informed of the purpose, the procedures, the possible risks and potential benefits associated with participation in this study. Any questions raised have been answered to the participant's satisfaction.

____
Name of study personnel

______________________________ _______________
Study personnel Signature Date signed

Version Date: 6/9/07

APPENDIX F – SAMPLE SITE AUTHORIZATION LETTER

Institution Letterhead

May 1, 2007

Cheryl Kamei Hannan, M.A., Doctoral Candidate
University of Arizona
4521 W. Camino De Cielo
Tucson, AZ 85745

Dear Ms. Hannan:

I have reviewed your request regarding your study and am pleased to support your research project entitled “Creative Typeset Requires Innovative Solutions”. Your request to use <<name of institution>> as a research or recruitment site is granted.

The research will include 3-5 visits from the principal investigator (Cheryl Kamei Hannan) or a research personnel (who may be a teacher from your staff). During these visits, the participants will learn to recognize print typeset indicators such as bold, italics, and colored words. Learning these symbols will be beneficial to test taking strategies and textbook skills. Participants will be paid monetarily, a small amount of $25.00 for students, and $100.00 for teachers. This authorization covers the time period of August 2007 to June 2008. We look forward to working with you.

Sincerely,

Name
Title

APPENDIX G – WORD LISTS FOR EACH PROBE

Probe 1 – Activity 1 word cards

Word Cards: Below is a list of the words on each word card.

Practice Cards Set #1: Each word/phrase is brailled in three forms (blue, red, and italics).

1. metal baseball bat
2. turkey sandwich
3. bubble-gum ice cream
4. dressed for school (*dressed* for *school*)
5. noticed
6. drawing
7. vanilla
8. already
9. scared
10. scoops

Practice Cards #2: Each word/phrase is brailled in three forms (blue, red, and italics).

1. balanced diet
2. cupboard is bare
3. basic food groups
4. parking lot
5. doughnuts
6. fudge
7. dragon
8. food
9. scratched
10. pushed

Probe 2 – Activity 1 word cards

<u>Word Cards</u>: Below is a list of the words on each word card.

Practice Cards Set #1: Each word/phrase is brailled in three forms (blue, red, and italics).

1. hearing and eyesight
2. backwards
3. round face and eyes
4. bend and twist
5. sharp
6. curved
7. very
8. beak
9. quietly
10. fly

Practice Cards #2: Each word/phrase is brailled in three forms (blue, red, and italics).

1. flock of Canada geese
2. breathe, see, and hear
3. facial disks
4. hippopotamus
5. sunscreen
6. curved
7. paddle
8. mammal
9. signs
10. outdoors

Probe 3 – Activity 1 word cards

Word Cards: Below is a list of the words on each word card.

Practice Cards Set #1: Each word/phrase is brailled in three forms (blue, red, and italics).

1. caught a perch
2. cannot wait
3. fishing rod
4. oyster cracker
5. bought
6. ugly
7. flounder
8. fantastic
9. handle
10. caught

Practice Cards #2: Each word/phrase is brailled in three forms (blue, red, and italics).

1. ice cubes
2. imitations of dogs
3. he chased cats
4. slurped coffee
5. messes
6. Maya
7. granddaddy
8. Julius
9. Alaska
10. Alabama

APPENDIX H – SENTENCES AND DIRECTIONS FOR EACH PROBE

Probe 1 – Activity 2 sentences

Sentences (PS1 & PS2): Below is a list of the sentences in print.

Practice Sentences #1

1. When I hit the home run I used a *metal baseball bat*.
2. The black panther was hiding in the bushes, and I was scared.
3. Can you *believe* he noticed the purple marker shape?
4. I'd like two scoops of *vanilla* ice cream, please.
5. The panther fell asleep downstairs in my basement.
6. Bubble-gum ice cream is my favorite.
7. I colored the drawing *blue, black,* and *purple*.
8. He already ate three sandwiches.
9. What happened to her?
10. On Mondays, I get dressed for school in the morning.

Test Sentences 1 (Must score 5 out of 5)

1. Someone put bubble-gum under my desk.
2. Are you *finished* with your drawing?
3. I would like a turkey sandwich.
4. Are you scared of panthers?
5. She *already* finished her ice cream.

If students are able to identify 5 out of 5 words with correct typeset indicators then proceed to Activity 3. If not, then continue with Practice Sentences #2.

Practice Sentences #2

1. A *balanced diet* is a *healthy diet*.
2. Some dragons can fly and breathe fire.
3. Doughnuts and fudge are tasty desserts.
4. When the *cupboard* is *bare* its time to go shopping.
5. My little dog scratched his ears.
6. Many cars were in the *parking lot*.
7. He had to push his car, when he ran out of gas.
8. What is a dragon's favorite food?
9. The cupboard has fudge doughnuts in it.
10. I pushed the *cart* for my mom when we went shopping.

Test Sentences (Must score 5 out of 5)

1. I *love* the fudge doughnuts.
2. I cannot find the car in the parking lot.
3. The cupboard has five cans of beams.
4. Will you push the cart?
5. This dragon was *blue* and *purple*.

Probe 2 – Activity 2 sentences

<u>Sentences (PS1 & PS2)</u>: Below is a list of the sentences in print.

Practice Sentences #1

1. Owls have good hearing and eyesight.
2. The *hippopotamus* loves to roll in the mud.
3. The hippopotamus is one of the largest mammals that live on land.
4. The white owl swooped down from the tree.
5. Many birds hunt in the *daytime*, but the owl hunts at *night*.
6. Check the ground for tracks of birds and other animals.
7. If you go for a hike, take an adult with you and let someone know *where* you are going.
8. A hippopotamus can swim underwater for *ten minutes*.
9. Owls like to perch on top of high posts.
10. *Watching wildlife* can be a fun adventure!

Test Sentences 1 (Must score 5 out of 5)

1. Did you see the owl last night?
2. Hippos like to rest in the water.
3. *Hippopotamus* is a Greek word.
4. Owls like to *watch and listen* while they perch.
5. Would you like to see a movie about owls?

If students are able to identify 5 out of 5 words with correct typeset indicators then proceed to Activity 3. If not, then continue with Practice Sentences #2.

Practice Sentences #2

1. Let's go for a *hike* in the woods and see if we can *see* some wildlife.
2. Insects like to live in streams and ponds.
3. The birds like to eat the *insects.*
4. Canadian geese make honking cries when they fly.
5. A hippo has a nose on top of its head so that it can breathe when its head is underwater.
6. Hippos often look like *lazy lumps* in the water.
7. Good hearing and eyesight helps the owl hunt.
8. Hippos like to eat grass.
9. Owls have soft feathers on their wings.
10. Did you see his *facial expression* when the owl swooped down to catch the mouse?

Test Sentences (Must score 5 out of 5)

1. I *love* to *hike* in the woods.
2. Insects live in dead tree bark.
3. Using your eyes, nose, and your ears can help you spot wildlife.
4. Don't chase the animals!
5. Owls can even *see in the dark*.

Probe 3 – Activity 2 sentences

<u>Sentences (PS1 & PS2)</u>: Below is a list of the sentences in print.

Practice Sentences #1

1. I cannot wait until *summer* when we can go fishing.
2. Chesepeake Bay is a *fantastic* fishing spot.
3. My father caught a *really big perch* last year.
4. An *oyster cracker* is a really ugly fish.
5. At the mall I bought a fishing rod.
6. Before we can cook the fish we have to clean it.
7. I like eating *fresh fish* for dinner.
8. Can we go to the lake today?
9. On *Monday* we will go to the mall.
10. A *flounder* is a flat fish.

Test Sentences 1 (Must score 5 out of 5)

1. *Perch*, *catfish*, and *flounder* are kinds of fish.
2. I keep my fishing rod in the trunk of the car.
3. I paid for it at the mall.
4. I *cannot wait* to go.
5. Fishing is fantastic!

If students are able to identify 5 out of 5 words with correct typeset indicators then proceed to Activity 3. If not, then continue with Practice Sentences #2.

Practice Sentences #2

1. I like to *bake cookies* and eat them with *peanut butter*.
2. Alabama is far away from Alaska.
3. An Alaskan pig would be a funny sight to see!
4. Maya loved Julius the pig.
5. *Everywhere* you go you will see big messes when a pig lives with you.
6. Out of the crate jumped the pig.
7. My parents would not let me have a pet pig.
8. The *polar bear* was from Alaska.
9. My granddaddy is from Alabama.
10. My cat can *surprise* you and do a good imitation of a dog.

Test Sentences (Must score 5 out of 5)

1. Julius was a fun pet to have.
2. I love to eat *peanut butter* on my *crackers*.
3. Can you make noise like a polar bear?
4. The red hat was soft and the blue pants were stretchy.
5. This dragon was *blue* and *purple*.

APPENDIX I – PASSAGES

<u>Test & Data Collection Probe (TEST)</u>: Below is a printed copy of the paragraph.

Test Passage

On *Monday* (1) after school (2), I sat down at my desk (3). I wanted to finish my drawing of a panther. I got out my *purple* (4), *black* (5), and *blue* (6) markers and started color. Just then, I noticed my panther blink (7). *Or* (8) *did* (9) *it* (10)? I got scared and ran to tell my mom. She gave me that look. I felt as if she didn't believe me.

That night I heard a noise downstairs. I got my dad's metal (11) baseball bat (12) from the closet and went downstairs. I saw a blue (13), black (14), and purple (15) shape. Then I knew. It was my panther causing the noise. He was in the kitchen making a *turkey* (16) *sandwich* (17).

My panther looked at me and asked, "Do you know where (18) the mustard (19) is?" I was so shocked that I went to my room and got dressed.

My panther and I walked to the ice cream store. He ate three (20) scoops (21) of vanilla (22). I ate two (23) scoops (24) of bubble-gum (25) ice cream. On the way home I fell asleep on the panther's back.

The next (26) morning (27), I woke up. I was already dressed for school. My mouth tasted like bubble-gum ice cream. Could (28) this happen to you? Did (29) this *really* (30) happen to me?

<u>Test & Data Collection Probe (TEST)</u>: Below is a printed copy of the paragraph.

Test Passage

People and other animals *rarely* (1) *see* (2) *owls* (3), even though some owls are quite large. Most owls are active at night and sleep during the day. They often sit close to tree trunks, on high branches. This resting place is called a perch (4). The owls' feathers blend in with the trees, making them very hard to see.

Owls look different from all other birds. They have round (5) faces (6) covered with soft, fluffy feathers. Their faces are outlined by two large circles called *facial* (7) *disks* (8). Owls have big, round (9) eyes (10). They also have sharp (11), curved (12) beaks (13) called *bills* (14).

Most other bird's eyes face to the sides, but an owl's eyes face straight ahead. The owl must turn its head to see something to its side. Luckily, owls' necks bend (15) and (16) twist (17) easily. An owl can turn its head so far that it can see *backwards* (18).

Sometimes it looks as if its head can spin all the way around! Owls also have very good eyesight. They can even see in the dark.

Owls use their sharp *hearing* (19) *and* (20) *eyesight* (21) to hunt for food. Most owls hunt only at night. An owl may sit on a tree branch, watching (22) and (23) listening (24). When it spots something to eat, the owl swoops (25) down (26) from its perch (27). Soft feathers on the owl's wings help it fly (28) very (29) quietly (30).

People do not need to be afraid of owls. In fact, we should be happy that they are around. Owls hunt mice and other pests that might otherwise bother us. They also are very beautiful animals. So the next time you are in the woods at night, listen for an owl "Whoo! Whoo!" Maybe if you hoot back, it will answer!

Test & Data Collection Probe (TEST): Below is a printed copy of the paragraph.

Test Passage

I bought a *new* (1) *fishing* (2) *rod* (3) that I haven't used yet. It is red (4) and (5) black (6) with white string and a black handle. I got my fishing rod at the mall and paid $11.99 for it. My father really liked the fishing rod that I picked out. It is in my (7) dad's (8) car (9) in the trunk in back of the car where I'll keep it until summer. Then I can use it a lot.

I caught three (10) fish (11) one day last *summer* (12) when I went fishing in Chesapeake Bay. My dad caught an oyster (13) cracker (14). A *flounder* (15) is as flat as a stone. The *oyster* (16) *cracker* (17) that my dad caught was covered with spots (18). I couldn't believe how *ugly* (19) it was!

After fishing, we took the fish home, cleaned them, and then we ate them. Once we finished eating the fish, we went (20) to (21) bed (22). We had a fantastic (23) time (24) fishing.

I cannot wait to use my new (25) fishing (26) rod (27).
I'll be glad when it is hot (28). Then I can go fishing and catch *all* (29) *kinds* (30) of fish like catfish, rockfish, perch, and flounder.

APPENDIX J – DATA COLLECTION SHEETS

Data Collection Sheet – Test Probe 1

Student # ________________________ Date __________________________

	Probe 1	Probe 2	Probe 3
Group 1	CBC	U_b	U_a

The directions for the activity will be explained as follows:

"Here is a story written in braille. Some of the key-words have been highlighted by the author using one of the three methods you were taught. Your job is to scan the story, identify the keywords, and tell me what kind of indication it has. You will be timed on how long it takes you to do this. But you will also be scored on if you get the type of indicator correct. So, you want to work as quickly as you can, but be as careful as you can about what type of indicator you are seeing. Do you have any questions about what you are supposed to do?"

If no questions, the researcher will say, *"When I say begin, you may start scanning the passage. When you are finished, say 'I'm done.'"*

Scoring:
- 2 = Correct word/s indicated and correct identification of typeset
- 1A = if the student identifies the word but not the typeset
- 1B = if the student identifies the typeset but not the correct word
- 0 = Neither word/s or typeset indicator was correctly identified

Test Probe 1 – Date ________________ Overall Score ___________ (out of 60)

Word	Score	Word	Score	Word	Score
1. Monday (I)		11. metal (bl)		21. scoops (bl)	
2. school (bl)		12. bat (R)		22. vanilla (R)	
3. desk (bl)		13. blue (R)		23. two (bl)	
4. purple (I)		14. black (R)		24. scoops (bl)	
5. black (I)		15. purple (R)		25. bubble-gum (R)	
6. blue (I)		16. turkey (I)		26. next (R)	
7. blink (R)		17. sandwich (I)		27. morning (R)	
8. or (I)		18. where (bl)		28. could (bl)	
9. did (I)		19. mustard (R)		29. did (bl)	
10. it (I)		20. three (bl)		30. really (I)	
Totals	2 _________	1A _________	1B _________	0 _________	

Seconds ______________________

Data Collection Sheet – Test Probe 2

Student # ________________________ Date ________________________

	Probe 1	Probe 2	Probe 3
Group 1	CBC	U_b	U_a

The directions for the activity will be explained as follows:

"Here is a story written in braille. Some of the key-words have been highlighted by the author using one of the three methods you were taught. Your job is to scan the story, identify the keywords, and tell me what kind of indication it has. You will be timed on how long it takes you to do this. But you will also be scored on if you get the type of indicator correct. So, you want to work as quickly as you can, but be as careful as you can about what type of indicator you are seeing. Do you have any questions about what you are supposed to do?"

If no questions, the researcher will say, *"When I say begin, you may start scanning the passage. When you are finished, say 'I'm done.'"*

Scoring:

2 = Correct word/s indicated and correct identification of typeset
1A = if the student identifies the word but not the typeset
1B = if the student identifies the typeset but not the correct word
0 = Neither word/s or typeset indicator was correctly identified

Test Probe 1 – Date ______________ Overall Score ___________ (out of 60)

Word	Score	Word	Score	Word	Score
1. rarely (I)		11. sharp (R)		21. eyesight (I)	
2. see (I)		12. curved (R)		22. watching (bl)	
3. owls (I)		13. beaks (R)		23. and (bl)	
4. perch (R)		14. bills (I)		24. listening (bl)	
5. round (bl)		15. bend (R)		25. swoops (bl)	
6. faces (bl)		16. and (R)		26. down (bl)	
7. facial (I)		17. twist (R)		27. perch (bl)	
8. disks (I)		18. backwards(I)		28. fly (R)	
9. round (bl)		19. hearing (I)		29. very (R)	
10. eyes (bl)		20. and (I)		30. quietly (R)	
Totals	2 ________	1A ________	1B ________	0 ________	

Seconds ______________________

Data Collection Sheet – Test Probe 3

Student # ______________________________ Date ______________________________

		Probe 1	Probe 2	Probe 3
	Group A	CBC	U_b	U_a

The directions for the activity will be explained as follows:

"Here is a story written in braille. Some of the key-words have been highlighted by the author using one of the three methods you were taught. Your job is to scan the story, identify the keywords, and tell me what kind of indication it has. You will be timed on how long it takes you to do this. But you will also be scored on if you get the type of indicator correct. So, you want to work as quickly as you can, but be as careful as you can about what type of indicator you are seeing. Do you have any questions about what you are supposed to do?"

If no questions, the researcher will say, *"When I say begin, you may start scanning the passage. When you are finished, say 'I'm done.'"*

Scoring:

2 = Correct word/s indicated and correct identification of typeset
1A = if the student identifies the word but not the typeset
1B = if the student identifies the typeset but not the correct word
0 = Neither word/s or typeset indicator was correctly identified

Test Probe 1 – Date ____________ Overall Score ____________ (out of 60)

Word	Score	Word	Score	Word	Score
1. new (I)		11. fish (R)		21. to (bl)	
2. fishing (I)		12. summer (I)		22. bed (bl)	
3. rod (I)		13. oyster (R)		23. fantastic (R)	
4. red (R)		14. cracker (R)		24. time (R)	
5. and (R)		15. flounder (I)		25. new (bl)	
6. black (R)		16. oyster (R)		26. fishing (bl)	
7. my (R)		17. cracker (R)		27. rod (bl)	
8. dad's (R)		18. spots (I)		28. hot (bl)	
9. car (R)		19. ugly (I)		29. all (I)	
10. three (bl)		20. went (bl)		30. kinds (I)	
Totals	2 _________	1A _________	1B _________	0 _________	

Seconds ______________________

APPENDIX K – GLOSSARY OF TERMS

BANA – Braille Authority of North America – an organization charged with maintaining rules and standards for the braille code. They also update the code and make recommendations for format of textbook production and techniques for transcription of braille materials.

Composition signs – symbols used into braille to convey conventions of print such as capital letters, typesets, numbers. These symbols do not have an equivalent print symbol because they are visual attributes that are inherent in print symbols (i.e. a lower case letter and upper case letter are shaped differently in print, but in braille they are shaped the same, therefore a composition sign is used to denote upper and lower case letters).

Contracted braille – the English Braille Code contains 189 contractions. Contractions include whole word symbols (i.e. c = can, *with* has a symbol), part word letter combinations (i.e. *ation*, *ch* have braille contractions to represent the part word), and short form words (i.e. ll = little).

Current braille code (CBC) – the Standard English Braille Code that is currently used for most school textbooks

Fishburne Alphabet – a tactile system of reading and writing that included lines in different angular shapes.

Font – the style of font used in word processed documents (i.e. Times New Roman, Arial, Comic Sans)

Format – the manner that braille is transcribed to indicate typeset. In this study the formats were current braille code (CBC), underlining with the indicator after the word (U_a), underlining with the indicator before the word (U_b).

Moon Type – a system of straight and curved lines that were embossed for tactile readers and used for transcription of printed materials.

New York Point – a tactile code used for reading and writing that included raised lines and dots, invented by William Bell Wait.

Standard English Braille Code - The braille code used in the United States, adopted by BANA, published in 1994 and revised in 2002 and 2007.

Typeset – visual attributes to text that varies the thickness, color, or tilt of a letter (i.e. bold, red/blue, or italics).

U_a – an alternative method of presenting typeset that utilizes an additional line spacing under the line of text containing a word with a typeset attribute. In the additional line spacing, the word is underlined using dots 1 and 4, and a letter is written in the last cell of the underline that indicates the type of typeset that is being used (i.e. b = blue, r = red, i = italics).

U_b – an alternative method of presenting typeset that utilizes an additional line spacing under the line of text containing a word with a typeset attribute. In the additional line spacing, the word is underlined using dots 1 and 4, and a letter is written in the first cell of the underline that indicates the type of typeset that is being used (i.e. b = blue, r = red, i = italics).

Uncontracted braille – alphabetic braille code, consisting of the 26 letters, punctuations symbols, and numbers.

REFERENCES

Accessible Textbook Materials Production Committee (ATIC) & Braille Authority of North America (BANA), (2007). *Promising practices for transcribing early literacy textbooks*. Retrieved from http://aph.org/atic/practices.html

American Printing House for the Blind (n.d.). Hall of Fame: Leaders and Legends of the Blindness Field, Samuel Gridley Howe. Retrieved, from the American Printing House for the Blind website: http://www.aph.org/hall_fame/howe_bio.html

American Printing House for the Blind (2006a). Distribution of eligible students: Based on federal quota census of January 3, 2005 (Fiscal year 2006). Retrieved, from the American Printing House for the Blind website: http://aph.org/fedquotpgm/dist06.html

American Printing House for the Blind (2006b). Distribution of eligible students: Based on federal quota census of January 5, 2004 (Fiscal year 2005). Retrieved, from the American Printing House for the Blind website: http://aph.org/fedquotpgm/dist05.html

American Printing House for the Blind (2003). Distribution of eligible students: Based on federal quota census of January 6, 2003 (Fiscal year 2004). Retrieved, from the American Printing House for the Blind website: http://aph.org/fedquotpgm/dist04.html

Ashcroft, S. C. (1960). Errors in oral reading of braille at elementary grade levels. Doctoral dissertation, University of Illinois, 1960.

Braille Authority of North America (BANA), (n.d.). *A short history of the Braille Authority of North America in the United States*. Retrieved from http://www.brailleauthority. org/history

Braille Authority of North America (BANA), (1994). *English Braille American Edition, 1994*. Retrieved from http://www.brailleauthority.org/ebae_entire.pdf

Braille Authority of North America (BANA), (2007). *BANA Braille Codes Update, 2007*. Retrieved from http://www.brailleauthority.org/BANA%20Braille%20Codes%20Update%202007-rev1.pdf

Braille Authority of North America (BANA), (2007a). *BANA in Brief, 2007*, Retrieved from http://www.brailleauthority.org/BANA%20in%20Brief%202007.pdf

Braille Authority of North America (BANA), (2007b). *BANA's Braille Unification Efforts*, Retrieved from http://www.brailleauthority.org/Braille%20Unification%20Efforts.pdf

Bürklen, K. (1932). Touch reading of the blind (F. K. Merry, trans.). New York, American Foundation for the Blind (original work published 1917).

The Shoder Education Foundation, Inc, (1996-2000). BRL: Braille through remote learning - Session 1: Introduction to writing for the blind. Retrieved February 12, 2007, from the Braille through remote learning website: http://www.brl.org/intro/session01/intro.html

Carreiras, M. & Alvarez, C. J., (1999). Comprehension processes in braille reading. *Journal of Visual Impairment and Blindness, 93*(9), 589-95.

Cooper, H. L., (n.d.). A brief history of tactile writing systems for readers with blindness and visual impairments. Retrieved from the Texas School for the Blind (TSBVI) website: http://www.tsbvi.edu/outreach/seehear/spring06/history.htm

Cooper, H. L., (n.d.). A brief history of tactile writing systems for readers with blindness and visual impairments. Retrieved from the Texas School for the Blind (TSBVI) Website: http://www.tsbvi.edu/Outreach/seehear/spring06/history.htm

Cranmer, T. V., Nemeth, A. (1991). A Uniform Braille Code [Letter to the members of the BANA Board]. Retrieved from the International Council on English Braille Website: http://www.iceb.org/cranem.html

Durre, I. K. (1996). How much space does grade 2 braille really save? *Journal of Visual Impairment and Blindness 90*(3), 247-51.

Foulke, E. (1979). Investigative approaches to the study of braille reading. Journal of Visual Impairment and Blindness, 73(8)298-308. As retrieved from International Braille Resource Center's Resource Library Website: http://www.braille.org /papers /invea/invea.html

Heller, M. A., Calcaterra, S. G., & José de Lima, F., (1999). The effect of orientation on braille recognition in persons who are sighted and blind. *Journal of Visual Impairment and Blindness, 93*(7), 416-18.

Horn, R. V. (2004). Technology: Typefaces. *Phi Delta Kappan 85*(10), 727. (ERIC Document Reproduction Service No. EJ703947).

Hulme, C., Maughan, S., and Brown, G.D.A. (1991). Memory for familiar and unfamiliar words: Evidence for long-term memory contribution to short-term memory span. *Journal of Memory and Language 30*, 685-701.

Irwin, R. B., (1955). The War of the Dots. New York: American Foundation for the Blind.

Kimbrough, Paula (n.d.). How Braille Began Retrieved February 12, 2007, from Enabling Technologies website: http://brailler.com/braillehx.htm

Kirschenbaum, V. R., (2006, May). The old way of reading and the new. *Educational Leadership 63*(8), 47-50. (ERIC Document Reproduction Service No. EJ745607).

Lorimer, P. (1996). A critical evaluation of the historical development of the tactile modes of reading and an analysis and evaluation of researches carried out in endeavours to make the braille code easier to read and to write (Doctoral Dissertation, University of Birmingham, 1996). Retrieved October 23, 2006, from International Braille Research Center (IBRC) website: http://www.braille.org/papers/lorimer/title.html

Lorimer, J. & Tobin, M. J. (1979). Experiments with modified grade 2 braille codes to detmerine their effect on reading speed. *Journal of Visual Impairment and Blindness, 73*(8), 324-28.

McGinnity, B.L., Seymour-Ford, J., and Andries, K.J. (2004) Founders of the Perkins History Museum, Perkins School for the Blind , Watertwon, M.A. Retrieved February 20, 2007, from the Perkins School for the Blind website: http://www.perkins.org/museum. section.php?id=186

Millar, Susanna, (1997). Reading By Touch. New York: Routledge.

Moon Literacy: What is Moon? (n.d.). Retrieved March 1, 2007 from http://www.moonliteracy. org.uk/whatis.htm

National Reading Panel (n. d.). What is reading fluency? Retrieved June 16, 2008 from http://www.nationalreadingpanel.org/FAQ/faq.htm#11

New York Institute for Special Education (NYISE), (2006). 175 years of service: Historical Origins, Saga of our Century, The first 100 years. Retrieved February 20, 2007 from http://nyise.org/history/NYI100.html

New York Institute for Special Education (NYISE), (2006). 175 years of service: Historical Origins, History of Reading Codes for the Blind. Retrieved February 20, 2007 from http://nyise.org/blind/barbier2.htm

Nolan, C. Y., Kederis, C.J. (1969). Perceptual Factors in Braille Word Recognition, Research Series No. 20. New York: American Foundation for the Blind.

Novemsky, Dhar, Schwarz, & Simonson, (2006, Winter). The effect of preference fluency on decision making in consumer marketing [Marketing Workshop]. Retrieved from the University of Chicago Graduate School of Business h*ttp://www.chicagogsb.edu/research /workshops/marketing/archive/WorkshopPapers/W06/novemsky.pdf*

Perkins School for the Blind, (2005). Mass Moments: March 2, 1829: Perkins School for the Blind Incorporated. Retrieved February 20, 2007, from the Perkins School for the Blind website: http://www. massmoments.org/print_moment.cfm?mid=68

Reilly, S. (2001). A Short History of the Braille Authority of North America in the United States. Retrieved from the Braille Authority of North America Website: http://brailleauthority. org/history.html

Rex, E. J., Koenig, A.J., Wormsley, D. F., Baker, R. L. (1995). Foundations of Braille Literacy. New York: American Foundation for the Blind Press.

Simmons & Nelson (2006). Intuitive confidence: Choosing between intuitive and nonintuitive alternatives. *Journal of Experimental Psychology, 135*(3), 409-28.

Sowell, V. & Sledge, A., (1986). Miscue analysis of braille readers. *Journal of Visual Impairment and Blindness 80*(10), 989-992).

Sullivan, J. (2008). Early History of Braille Translators and Embossers. Retrieved electronically from Duxbury Systems, Inc. Website: http://www.duxburysystems.com/bthist.asp

UBC Report: Japan (1998, July 13). Retrieved from the International Council on English Braille Website: http://www.iceb.org/ubcevjp.html