THE BRAILLE PROJECT

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INTRODUCTION

The blind are a minority within a minority, a community that constitutes a small number of those living with physical disabilities and that do not garner much attention in the health care field. Moreover, the Braille literate populace has become marginalized in the past few decades. There is a need for the incorporation of Braille in today's technology; to blind individuals, reading Braille offers many of the same cognitive benefits and emotional gratification one would expect with reading printed words.

This paper explores the benefits of maintaining Braille literacy in older adults in countering age-related changes in their physical and cognitive abilities. The challenge is to make blind assistive technology that is tailored to the aging populace with consideration for common co-existing functional declines that make Braille more difficult to read. Design ideations that preserve literacy in blind older adults will be presented and encourages further exploration into technology that will allow the blind to gain greater independence and quality of life.

BACKGROUND

While the health care world is focused on the aging population and the subsequent rise in the number of people with hypertension, diabetes, and other more publicized medical conditions, a less known forecast is one made in 2004 that predicted a 70% increase in the prevalence of blindness in the United States of America by 2020.[1] Also consider that the leading causes of blindness include macular degeneration, diabetes, glaucoma and cataract, all of which are age-related medical conditions. The statistics on Braille literacy are also important to note. In the U.S.A., only 10% of the 1.3 million blind individuals can read Braille.[2] Some of the major obstacles leading to the decline in the use of Braille include an increased reliance on audio-based technology, the difficulty of learning Braille, the lack of availability of Braille material, storage concerns due to the size of the books, and the perception that Braille reading is outdated.

Despite these statistics, there has been an increase in international awareness of the benefits of Braille in improving literacy as demonstrated by efforts of the National Federation of the Blind in advocating the American government to recognize "the critical role Braille plays in the independence, freedom, and success of the blind."[2] It is noted in the blind community that individuals who are Braille literate have a higher employment rate and greater ability to live independently, being capable of using Braille for the labeling of items or for recreation in the form of card games.[3] While statistics show there is a need for more innovations in Braille technology, this increased international awareness also reflects a desire for these improvements.

METHODS OF RESEARCH ON THE BENEFITS OF BRAILLE

A search of the literature was conducted to explore the benefits of preserving Braille literacy in older adults, specifically in how it slows decreasing finger tactility and cognitive decline. Studies were found in PubMed and AgeLine, along with manual biography searches, using the keywords of Braille, tactile acuity, cognition, and leisure activity. Results were limited to English. Any information on Braille assistive technology is based on articles from science and technology websites. Another source included a personal interview with a blind older adult living in an assisted care facility who has decreased finger sensitivity. The detailed, personal information gathered was extrapolated to understand the emotional impact of losing the ability to read Braille.

RESULTS

Preservation of tactile acuity

There have been a number of clinical trials over the past few decades that have assessed the tactile acuity of blind subjects' fingertips as compared to their sighted peers of the same age group. These studies suggest a few reasons why acuity may be enhanced, including the idea of an adaptive enlargement of the reading finger representation in the primary somatosensory cortex.[4]

Passive or active paradigms were used in the studies to measure a subject's tactile threshold and recreated conditions an individual experiences when reading Braille. The passive models included the 2-point threshold test that observes a subject's ability to discriminate between two simultaneous contact points[5] and active models included tactile-acuity charts that mimic the Snellen letter chart for visual acuity.[6]

A summary of the evidence concludes that blinded individuals have a lower average tactile threshold (correlated to higher acuity) than age-matched sighted subjects.[6] The studies found an age-related decline in tactile acuity in the blind subjects similar to sighted subjects, but two studies done by Goldreich & Kanics which used grating orientation or detection tests found that the average blind subject had the acuity of an average sighted subject of the same gender but 24 years younger.[4,7] A study by Legge et al. suggested that the use of active touch in daily activities, not exclusively Braille reading, resulted in preservation of tactile acuity as the blind subjects aged.[6]

There were other relevant points made by the studies. The spacing between the two columns (Figure 1) that make up each Braille cell or character (2.28mm) is near or beyond the acuity limit of older adult readers (2.0-2.5mm).[6] Goldreich & Kanics found that an increase in the force of contact between the surface of the test stimuli and the skin (i.e. 50g of force versus 10g) significantly improved the acuity of the subject's fingertips by almost 1.0mm.[7] These conclusions have important implications in the design of Braille assistive technology for older adults.

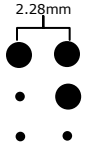

Figure 1: Braille cell

Preservation of cognitive function

Braille reading may also play a role in slowing the decline of cognitive function in older adults. Data from the studies will be extrapolated to include Braille as a means of literacy and a form of complex leisure activity to demonstrate this possible correlation. There have been various cohorts conducted in groups of well-educated or less-educated older adults that used a range of cognitive measures to develop a correlation between higher literacy rates and higher cognitive function, such as an evaluation of the subject's global cognitive status, executive function, verbal memory, and verbal fluency.[8] Barnes et al. found that literacy has a strong, linear association to performance on cognitive tests across all cognitive domains.[8] Similarly, a review article postulated that subjects who have a higher education level and/or are more involved in cognitively stimulating activities may experience a slower decline in cognition due to protective neurological effects.[9]

Moreover, there have also been studies evaluating the effect that participation in cognitively stimulating activities has on the incidence of Alzheimer's Disease (AD).[9,10] For example, one study interviewed AD-free older adults about participation in cognitive activities at baseline and performed a stratified random sample of the community 4 years later. They found that on average the subject with infrequent cognitive activity was two times more likely to develop AD than the subject who was frequently cognitively stimulated.[10] This conclusion is consistent with other journal findings. There have also been studies suggesting intelligence as estimated by literacy, years of education, and cognitive stimulation have been associated with a decreased risk of dementia.[8] Due to limitations within and the heterogeneity amongst the various studies, correlation, not causation is suggested. Braille reading is a means to improve literacy and acts as a form of complex leisure activity and the findings found in sighted older adults can be applied to the blind.

Current Braille technology

There are many design ideas for Braille assistive tools, but only a few are readily

available to the public. One of the most popular concepts is the refreshable Braille display, the Braille equivalent of the eReader. However, current Braille readers can only display one line of Braille at a time, making it hard to follow, and can cost $3,500 to $15,000.[11]

Other advances focus on the manufacturing process of Braille itself, including expanded-cell Braille, commonly known as Jumbo Braille. The horizontal distance between the dot columns of each cell is wider than in standard Braille. It is tailored for individuals who are beginning to learn Braille or who have decreased fingertip tactility.[12] Also, instead of writing Braille by inversely embossing the cells onto the back of the paper, there is a method formulated in Korea that uses a clear, glue-like substance to print onto the paper.[13] There have also been Braille printers with computer interface, portable electronic notetakers, and other devices that make Braille material more readily available to the common household.

DISCUSSIONS

Learning from the evidence

New blind assistive designs need to focus on prolonging and preserving an individual's ability to read Braille to enable the user to experience the cognitive and social advantages of reading. Another aspect that could be included in the design includes increasing the space between the two columns of each Braille cell, as in expanded-cell Braille, to compensate for the decreased tactile threshold in older adults. A couple of studies suggested that increasing the force exerted by the fingertips on the Braille has also been found to improve the ability to discern each cell.[4,7] Incorporating the ideas of making the Braille dots more raised and prominent along with changing the durability of the material, such as the glue-like substance used in Korea,[13] would allow the reader to exert more force onto the Braille cells.

There are other specific considerations that should be addressed when designing for the older adult population: user-friendliness for the less technology-adept individuals, portability, and accommodation for any onset of fatigue that renders individuals unable to concentrate on the activity of reading.

The design must not merely satisfy a client's functional necessities, but also their emotional desires. The interview with the blind older adult living in the assisted care facility made clear his desire for an intellectually engaging activity, such as reading his Braille books. It was a hobby he loved and missed after losing some of his physical ability to read the Braille cells. Similar to the strong attachment many sighted individuals feel for their printed literature, blind individuals also experience an emotional connection to their Braille writings.

From these considerations, two design ideations have been postulated that satisfy the needs of various personas in the older adult populace: The Touch Book and the Touch Aid. The purpose of both prototypes is not to restore an individual's lost tactility, but allow an individual with diminishing tactile acuity in the fingertips to read certain Braille cells he could not otherwise read without an assistive device.

The Touch Book

The target audience for the Touch Book (Figure 2) is the generation of older adults who want the sensory details they once enjoyed from reading books. The texture of the paper and the act of turning pages are emotive experiences that cannot be recreated through the use of Braille displays or audio tapes.

The device would communicate through the means of Braille, auditory, and printed text. The audio interface can assist the individual when they come across a Braille cell that is difficult to read, for example, due to a decline in finger tactility or fatigue in extended periods of reading. Having printed text written underneath the Braille allows intervention from Braille illiterate caregivers and also creates opportunity for social interaction as both the blind and sighted can follow the text together.

The product would require custom paper set inside an interactive book case that produces audio feedback. Sections of a book would be subdivided into thinner and more portable leaflets. Most importantly, the Touch Book would need to feel like a traditional Braille book that is aesthetically appealing to the generation that is uncomfortable with complex technology.

Figure 2: Preliminary sketch of the Touch Book by Katelynn McKenna

The Touch Aid

The Touch Aid (Figure 3) is made for the future generation of older adults who are receptive to using more sophisticated technology. A pressure sensor placed on the fingertip has the capacity to sense the embossed Braille cell and transmit the dot pattern to a receiver lying flat on the wrist and held down by Velcro straps. The reader senses the cell with the tactile receptors of the skin of the wrist, where tactile acuity has not diminished, instead of the fingertips. The receiver converts the signal into a pressured force or "imprint" of the read Braille cell onto the skin. The degree of force can be adapted to the level of difficulty the reader is experiencing in sensing the cell by adjusting the Velcro straps.

The main advantage of this design is that it would contour around the reader's fingertip and hand to allow him to read Braille as he would normally. It has an appealing simple and modern design as a single seamless unit to ensure portability and minimize the risk of losing individual pieces. The Touch Aid is versatile and assists in the reading of any existing Braille text for any degree of difficulty the reader may be experiencing.

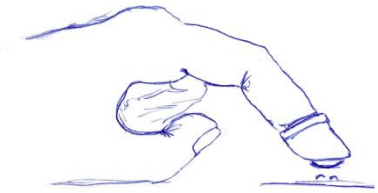

Figure 3: Preliminary sketch of the Touch Aid by Katelynn McKenna

CONCLUSION

Development of Braille assistive technology will promote Braille literacy in the blind community. Age-related factors, such as poor tactile response, have to be taken into account when creating products for the aging population. From a health care perspective, preserving a patient's ability to read allows them greater independence in managing their medication, lifestyle and various medical needs by giving them access to health information in Braille. If the design takes these considerations into account, technology can play a vital role in improving the health and quality of life of blind individuals.

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