Uses of Tactile Sensation of the Blind

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Abstract

Individuals explore the world in a variety of different ways. The difference between common ways to interact with one's environment becomes greater when a disability is involved. One of the most limiting disabilities in a society of visually inclined is blindness. Blind individuals adapt in many ways, one of the more common is by learning to "see" by touch. This paper will explore some of the various ways that the blind use the sense of touch, specifically pattern recognition, to be aware of the world around them.

Keywords: blindness, touch, sensation, perception, tactile pattern recognition

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Sight is used for a number of things in the human experience. The uses of sight include communication, aesthetic analysis, navigation, reading, identification and numerous others. This most vital sense can be lost in a several ways, ranging from birth defects to accidents or disease. Touch is a common substitute for many of the tasks usually handled with sight when sight is lost. Through the use of tactile pattern recognition the blind can read, learn about their world, and in general function as independently as a person with full sight.

There are varying degrees of blindness and not everyone who is blind began life in that condition. A very small percentage of blind individuals are born completely blind. Typically only individuals who are completely blind must depend on some type of aid for navigation, but each individual is unique in what aids they require to functional normally with diminished or absent vision (Manning, 2006).

Touch, like other senses, is a very complicated chain of systems that communicate from the sensory organ, in this case the skin, to the brain. The process for pattern recognition begins in the epidermis, in special mechanoreceptors called Merkel cell neurite complexes, often called SA I units (Wolfe, 2006). Using these receptors for detailed tasks, such as reading textures (Braille, for example), is not something natively intuitive to sighted people. Just as it takes time for an infant to learn detailed use of eyesight for locating contours, or being able to attune to specific stimuli in a meaningful way, it also takes time to develop a highly attuned sense of touch. Beyond basic textures and patterns there is pictorial comprehension, the ability to understand a shape or pictogram. It is theorized that such abilities are quite similar between sighted and blind individuals. It is thought that in some situations of pictorial recognition blind individuals with knowledge of Braille can identify more shapes more quickly than their sighted counterparts because of their self-guided tactile exploration skills (D'Angulli, 1998). In a study conducted by Amedo D'Angulli, et.al. (1998), it was determined that blind children use the same strategies for comprehending shapes as sighted children and have a similar understanding of shapes, as there is a strong correlation between the performance of each group. The theory that sighted and blind individuals "see" shapes the same way is further supported by another study, conducted by Toro Graven (2005), in which it was determined that there is an advantage in shape identification for newly blind individuals for shapes that they were introduced to before being blinded. The study used sighted people who were blindfolded, giving them no advantage of being previously trained in shape recognition without the aid of sight (Graven, 2005). There are experimental devices that are designed to take advantage of the heightened awareness of touch, which blind individuals often develop, to provide visual information in a tactile way. The device provides tactile stimulation on the abdomen that correlates to the visual field that is detected by an electronic sensor. The sensor converts the visual input into low-intensity electrical impulses that are translated into either pressure or vibrations on the abdomen of the blind infant. The theory behind the use of such a device is that it would be similar to a language form that an infant would learn, just as they would ordinarily learn certain visual cues. In some trials, basic understanding of the device's translations were possible for some subjects after just a few hours of training (Segond, 2007). The abdomen is by no means the most sensitive location on the human body for tactile input. The fingertips are the most sensitive, containing many SA I mechanoreceptors, with an average tactile resolution of about one millimeter. However, this resolution is not a constant. It is thought that much like eyesight reduces in resolution with age, mechanoreceptors also degrade in a similar way, and as an individual ages their ability to discern small details by touch becomes less accurate (Manning, 2006).

In addition to fine characteristic recognition, there is also a more course use of touch that most blind individuals use in their daily lives for navigating unfamiliar environments. The use of a cane is common for the blind. It is an essential tool for keeping the blind individual safe while engaging in any type of independent activity outside of their home. The cane is tapped in front of an individual and moved from side to side, checking the path of an individual. As a result of this process, a blind individual using a cane is less likely to trip over an object and fall than a sighted person (Kim, 2009). The movement of the cane ensures that there is a clear bath for the individual, as well as assists in providing information to sighted people as to the direction in which the blind person is intending to move, allowing them to stay clear of their path. The tapping of the cane allows the blind individual to know what is in front of them, and especially provide distance information for whether there is any form of drop or other unusual ground in front of them. If uncertain of the surface, they may drag the cane and feel the resulting vibration to know what type of surface they are about to be on, to be prepared for a surface that may be slick, such as a freshly mopped floor, or something uneven and unstable, such as gravel. Blind people primarily navigate with mental maps. It is often a lengthy and difficult process for learning a new place, a task that becomes more difficult if there are large numbers of people in the space. A lot of the difficulty encountered is due to the fact that blind individuals learn places like others may learn other physical skills. Just as a child cannot learn to ride a bike in a day, it requires repetition and rehearsal for a blind person to learn enough about an environment to allow them to navigate competently in them. Braille encoded maps, or maps with raised lines can also be used for navigation, but they are considered by many to be cumbersome and interfere with other tasks, which defeats the purpose of independent mobility. Tactile information is preferable to auditory instruction because situations sometimes have a variety of auditory stimuli, which may make comprehension of the navigational information difficult (Lahav, 2006).

Another area where usually vision is the normal sensory modality is art and aesthetic analysis. A majority of art forms are visual, and as such, tend to be somewhat inaccessible to the visually impaired (De Coster, 2004). There are two sides to this area of concern regarding the blind, the first is their ability to create art, and second, to be able to experience it. Some blind individuals may find it especially difficult to appreciate art because art education is primarily intended for and intended to accommodate the sighted. This limitation in art education may deter some blind from approaching art, and certainly limits the amount of artistic expertise that a blind individual may acquire. Topics such as form, balance and contrast are common in visual arts, but can be applied to tactile analysis of a work as well. Relief carvings that utilize textures and raised lines allow for the easiest access to art for the blind, but can sometimes be restricting due to the limitations of the fingertips to resolve very small details, and very fine variations in the height of marks. Ceramics and sculpture can provide a blind person with a novel tactile experience. The major concepts of art, balance, form and contrast are easily distinguishable in these forms, and their appearance is not important to their impact, unlike two-dimensional works. People who are blind may have great difficulty with understanding abstract works without a minimum of art education, as the stimuli normally encountered by most is of a more literal nature. There are many art forms to which visually impaired people do not have easy access, which sometimes inspires the more artistically curious individuals to explore art from the creating side (De Coster, 2004). One of the more common daily artistic engagements of the blind is raised-line drawing. It is accomplished using a special board which allows normal paper to be used with a pen or Braille stylus to make indentions in the paper, which is a raised line once inverted. These raised-line drawings are often of things that are familiar to the individual, such as the faces of friends or family. Through a methodical touch process a blind individual can trace a face for general features, reproduce those in a raised line drawing and then fill in the details with another pass of touching, to determine textures and lengths of hair. Many researchers have been surprised at the level of detail, complexity and accuracy of drawings produced by blind children. One study revealed that blind artists have the same capability for understanding things that are typically thought of as visual concepts as sighted individuals. Those typically visual elements include perspective and foreshortening. A blind person is just as likely to draw a fence disappearing into the distance as a sighted person. (Kennedy, 2006).

Some industries are taking the blind into consideration when designing new products. One of the more visible examples of this consideration is in the building materials industry, where increasingly items designed to be installed in public spaces are being printed with Braille for identification and navigation. One recent invention is a method for printing Braille directly on semi-hard ceramic tiles, which allows for unique signage to be placed on select tiles pulled from a mass production batch, allowing Braille signs to be easily integrated into building construction plans. This process could also allow for other industries to include Braille in their construction process, such as container manufacturing. Once a method is created to imprint the Braille characters into the moulds used to create glass and plastic containers, it would be possible to make almost all product packaging accessible by the visually impaired (Zhang, 2004).

Braille is one of the most recognizable ways that blind individuals use touch to interact with their world. Braille is an adaptation of a French technique known as “night writing” that was created in 1821 by Louis Braille. “Night writing” was originally designed by the French military as a silent form of communication, but it was determined to be too complicated for most soldiers to learn. Night writing used twelve dots in a single cell, which was determined to be too difficult to read, for a variety of reasons, but primarily because it would require the reader to move their finger for reading a single character. Braille designed a more reasonable system using only 6 dots (Swenson, 2010). The system allows for 63 potential characters, minus a few that are restricted due to being too similar to other characters. Braille is not permanently mapped to a set of characters. In each language the base characters tend to keep the same meaning, but some of the characters change depending upon the context, such as with mathematics. There are also some options for contractions in the system. The contractions are for common words or letter combinations, such as “and” and “th”. These contractions are not usually part of the language used for book publishing, but are often used by individuals to shorten the time it takes to read and write such words. Braille is more structured in its progression than a spoken or written language. There are three distinct “grades” of Braille which become progressively harder to read, but yet provide for increased efficiency in reading. The difference between grades is the application of certain contractions and special symbols. Grade 1 Braille does not use any contractions or special characters, whereas grade 2 introduces numerous common contractions as well as a set of single letters that represent complete words. Finally, grade 3 Braille is a complete system of contractions which allow for almost a shorthand usage (Wetzel, 2006). The Braille system has been expanded to allow for up to eight dots, but it has been determined that additional dots would make the system too difficult to use. The expansion to eight dots allows Braille to have the same number of character representations available as is available to a standard computer character, 256 (Swenson, 2010). In 1999, Braille was assigned the 2800 through 28FF number space in the Unicode typeset structure, giving it a standardized way to be represented on all computer platforms, further increasing its accessibility (Unicode, 2010). The addition of Braille to Unicode makes the process of writing documents for the blind by the sighted a simpler process; however, it is interesting to note that a large number of blind individuals choose to learn touch typing skills, usually with the guidance of special key markers. Blind individuals who input text through the touch-typing method will often receive computer output on a device known as a Braille board, a mechanical board that raises and lowers sets of pins to allow the user to read across as output is produced (Rose, 1981). Modern computer operating systems have been criticized for their lack of usable output for blind individuals. For users with sight difficulties there are high-contrast and large-print modes available, but for the fully blind user, there is very little assistance provided. In the early days of personal computing it was a much more simple matter for blind individuals and computers to communicate. Initially with punch cards the blind user and the computer "read" in exactly the same way, by the presence or absence of dots. When text-based graphical computing systems were introduced the computer provided text as output that could be easily interpreted by a machine for the user, and the user could easily use the same machine to input their commands. In modern computing, there is a higher reliance on pictographs and other graphical modes of computing, often allowing the sighted individual to attune to specific information they wish to utilize. This process is more difficult for the blind user, as there is no established mechanism to effectively reproduce all of the available output at once, and if there were such a mechanism it would likely be overwhelming for the user (Shinohar, 2009).

It would seem that the world is just as accessible to a blind person as a sighted person, but there are a few restrictions. One of my most notable restrictions is in the area of commerce. In the United States there is no way to determine one denomination of currency from another when using paper bills. All bills have the same uniform texture across them and are exactly the same size. This differs for Canadian currency, as the Canadian minting process utilizes a pseudo-Braille system for monetary identification. Braille cannot be used because of how fragile the raised bumps are. The circulation of the currency would result in far too much damage to such a precision arrangement of dots. Instead, the Canadian mint utilizes a full six dot Braille cell on each bill, with varying denominations having a different number or arrangement of the cells. The American Council of the Blind has proposed numerous solutions to the absence of any type of tactile identification of bills in the United States. Some of the most feasible options are raised dots like those used in Canada, different texture papers for each denomination or some type of notch system that would not interfere with the normal use of the bills. In no financial system is there a method for a blind person to be able to easily write checks or read checks written to them. This is a limitation which makes it more difficult for the visually impaired to determine if they have been compensated properly (Falconer, 2009). There are limitations on what a blind person can accomplish financially without assistance, and in a lot of situations a blind individual must trust a store clerk to identify the correct bills for them, when it would be much simpler for a blind person to be trust their own fingers in those situations.

There are limitations in experiences that blind individuals may have. There are some aspects of the world around them that they may never have a complete awareness of, such as color and the effects of light. The sense of touch is a suitable alternative to vision that allows for day-to-day functioning, as well as accessing some of the finer elements of humanity. Literature, art and independent function are not outside of the realm of access for a visually disabled person.

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