Creating an Audio-Tactile Braille Storybook for Visually Impaired Children: The Role of Audio Feedback in Inducing Pleasure

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Introduction

In the psychology of reading, choosing an appropriate and attractive book and engaging children with the book are two of the important issues in creating motivation and interest in a young reader.Given the choice, children choose story books with more illustrations (Edemunds and Bauserman 2006) andselect books that are personally meaningful and interesting.There are some other ways to encourage children to read. In the past, teachers used methods and resources such as reading aloud and playing narrated audio recordings to motivate and teach reading skills. With the advances in of educational technologies, computers, e-books (multi-media books) can have been more recently enlisted to stimulate the desire to read for pleasure(Strout 2010).

The research on traditional paper books can, with exceptions, be divided into two categories. The first category focuses on reading speed, getting information and reading comprehension. The second focuses on reading for fun and reading as a leisure activity. Research in this second category, includes preferring to read, motivation and enjoyment, but unfortunately when it comes to the electronic books most of the research has been done in the first category (Colombo and Landoni 2011, Moore 2009), and what has been emphasized is teaching reading skills to the children, rather than emotional aspects of an enjoyable reading (Skouge et al. 2007).

The e-book's interactivity gives feedback to the children. It engages them and encourages them to explore and to keep on reading. They change their attitude toward reading, increase their imagination and reading comprehension(De Jong and Bus 2003, Moody et al. 2010, Korat and Shamir 2010, Matthew1996).

Multi-media books usually use visual featuresand visual feedbackto engage their readers, when blind or visually impaired children only have their other senses to gather information (Crossan and Brewster 2008).This is unfortunate, because research shows that something like the engagement of multi-media books is just what blind and visually impaired children need to be able to read for pleasure. The research findings have two aspects.

Firstly, teachers of children with low vision report that, in general their students are poor readers. Research supports the observation that children with low vision do not read as well as sighted children of the same of age (Gadagbui and Ocloo 2008). Reading Braille takes longer than reading printed text. Print readers can read faster than a Braille reader (Fellenius 1999 and Eskenasi 2011).This slow progress is known to be demotivating (Sánchez and Galáz 2007), so it can be expected to hinderthe exploration of Braille (Wright 2008), so the first learning of Braille needs to be a stimulating andan exciting experience (Hatlen and Spungin 2002).

Secondly, literature and reading story books for children with a disability are a kind of therapy; bibliotherapy, that can decrease the depression and negative emotions in these children (Myers 1998). For instance, trying to keep up with their peers without adequate support can cause visually impairedstudents to become clinical depressed (Freeman et al. 1989) and cause preschool children with visual impairment become segregated and socially isolated (Sacks and Gaylord 1989). So, there are additional benefits in reading books for blind children. Bookscan help them solve the problems that they encounter in their life. Books can assist them gain independence and to not feel sorrow for their disability(Pardeck1993).

To provide blind children equal opportunities to enjoy reading with storybooks, the Braille publishers use tactile illustrations besides the Braille text of the books for

blind children. Like visual illustrations, tactile illustrations have been observed to add interest and meaning to story reading for blind children. Students with little previous interest in books, showed increased interest in reading tactile books. In addition, teachers report that some students use the book's tactile pictures to help them pretend read (Wright 2008).

However, a tactile illustration can never be as complete as a visual picture, as a blind child cannot seeitin perspective (Crossan and Brewster 2008). As it is two dimensional rendering of a three dimensional world, it is difficult for a blind child to comprehend, as spatial relationships are difficult to convey in a tactile illustration.

Psychophysical research indicated that congenitally blind people; people who lack any visual experience, havedifficulty recognizing tactile pictures because of the haptic perception limitations and their lack of haptic experiences with tactilepictures(Heller et al. 1989, Lewis and Tolla 2003, Jehoelet al. 2006, Pathak and Pring 1989, McCarthy 2005, McGee et al. 2001).However, experiments using haptic picture matching (to eliminate semantic memory) support the view that agood understanding of perception can be developed in the absence of visual experience (Heller et al. 2005). There is a body of research that supports the view that tactual picture perception is considerably more difficult than visual picture perception (Loomis and Klatzky 2007, Loomis et al. 1993).Research has concluded that tactile illustrations have always needed associated audio data; usually an explanation by a sighted person(Landua and Wells 2003, Walls and Brewster 2000). Braille explanations are of limited use because they considerably lengthen the book's Braille text, which tires children. In any case, some blind children (especially those who have developmental problems) show a lack of interest in haptic exploration of objects (Jan et al. 1983).

From the other side, multi-sensory research hasindicates that we have separable spatial attention systems for touch and audition. There is some evidence that supportsthe hypothesis that the integration of information across different modalities facilitates perception (Hotting and Roder 2009, Lahav and Mioduser 2007, Jacko et al. 2003).For instance research shows that auditory cues automatically attract attention and that allocating attention to a sound facilitates visual processing as well (Hotting and Roder 2009).
Psychoanalytic study of children indicates that children tend to master their external world through activity.Blind babies attempt to producesounds by performing a noisy activity andattempt to repeat the noises that they hear. Blind children show a high degree of sensitivity to noise and display an early development of skill in differentiating and imitating sounds. They can gain pleasure making and listening to the sounds (Sandler and Wills 1965).This is supported bycontrolled studies on sound and tactile picture perception that show, that in comparison with sighted peopleand in contrast their tactile picture perception, visually impairedsubjects perform better in perceptual auditory tasks (Canadian National Institute for the Blind, 2012).
Work with visually impairedchildren with multiple disabilities, it was found that engaging auditory material prepares a child to search for and select from appropriate tactile targets(Goldware and Silver 1998). All this suggests that blind children's storybooks might be made more engaging if sounds and audio tracks were incorporated into them.
Ideas, Design and Fabrication details: In the idea stage I studied the Braille storybooks that had produced in Iran for Iranian blind children. In the school libraries there were no Braille story books with tactile illustrations for blind children. All the

books just had Braille text only and those with tactile illustrations,were picture books; story books with tactile illustration, without Braille text, for pre-school children.

To design, my Audio-Tactile Braille Storybook I considered, firstly the needs of visually impaired Iranian children and secondly, the desirabletechnical features of an Audio-Tactile Braille Storybook.

An Audio-Tactile Braille Storybook had to have a Braille story text because both Braille and story narrative play a very important roles in a visually impaired child's development, and ithad to be suitable for the child's age as a beginner Braille reader in Iran.The story had to be related to Iranian culture and book had to usean accessible and low cost technology that was available in Iran.

The basic technical requirements of the Audio-Tactile Braille Storybook were firstly, that it had to be user friendly and affordable tothe parents of visually impairedchildren. Secondly, it had to have a Braille text. Thirdly, it had to have a variety of sound effects or audio narrative buttons, and fourthly, it had to have a tactile illustration, with a single sound cue, on each page. I also particularly wanted the visually impaired children's parents to be able to add sounds and pages to the book, to create additional storybooksfor their children.

My Audio-Tactile Braille Storybook consisted of hardware, software and book pages. The hardware had aPVC plastic frame. The enclosed panel consisted of two sections. The section on the left side, which was for placing the Braille text,was hard plastic and on the right side there was a touch panel, which was powered from the computer via a USB cable.

The software of the Audio-Tactile Braille Storybook was written with Delphi programming language with the use of Access Data Base. This software can be run on Windows XP or Windows 7 and it doesn't need installation. On selecting the title of the book, the main virtual window of the book appeared.This consisted of a blank page with ten buttons in a vertical column and a button for the single sound of the tactile picture on the page. It did not have any text or picture. It just had buttons that were connected to the sound files that had been saved on the hard disk of the computer. It also hadbuttons for going to the next or previous page. Figure 1 shows the touch screen display.

The book's pages were made of cardboard and had the Braille text glued on the left side and the tactile picture glued on the right side. Tactile plastic buttons with adhesive on the back side of them were struck on the book's page in the margin between the Braille text and the tactile picture. Figure 2 shows an example of the page of the Audio-Tactile Braille Storybook.

The story I chose for my first Audio-Tactile Braille Storybook, was the story of, 'The Trundling Gourd'; 'kadooyeghelghelehzan'. This is a Iranian folk story. The version I used was a new Braille edition of thirteen paper pages. I chose suitable sound effects related to the story line on each page. As I added these to the software I stuck plastic buttons on the right side of the pages of the Braille text, in a vertical column coincident with the virtual buttons on the software window. I made the tactile pictures for the story with different textures. I used the special rules for making tactile pictures for blind children that comes from American Printing House for the Blind(American

Printing House for the Blind, 1997).Each page had a tactile pictures and sounds, except page 7 of the book which did not have any sound buttons at all. It was silent. It had just Braille and a tactile picture. I planned this to see what the children's reactions and comments for this page would be after experiencing the previous pages with sounds.

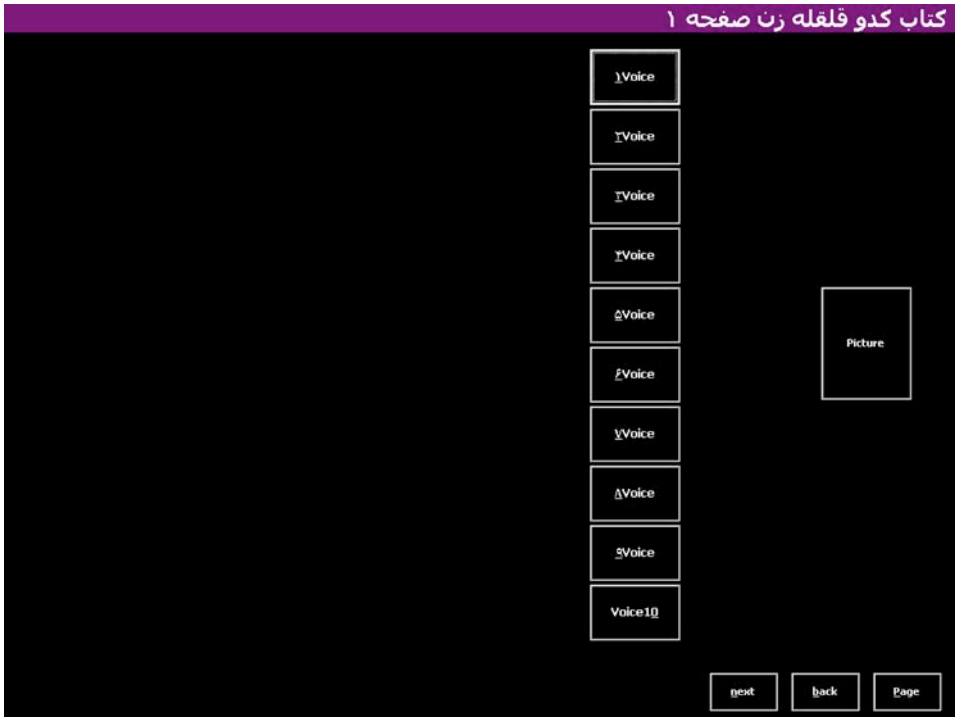

Figure 1 Audio-tactile touchscreen software display.
The only the areas inside the button boxes are sensitive to touch. The numbered button boxes labeled Voice are linked to sound effects for the Braille text. The button box labeled Picture is linked are linked to the sound effect for the picture, and the button boxes labeled ‘next’, ’back’ and ‘Page’ effect navigation.

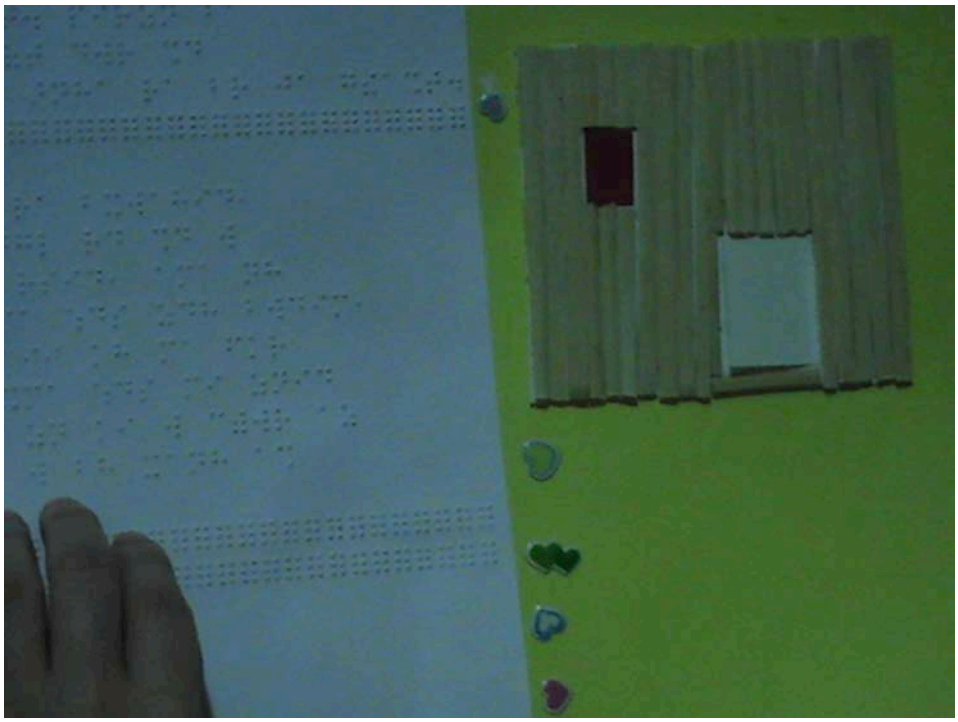

Figure 2 A page of the Audio-Tactile Braille Storybook.
The Braille text is on the left-hand side. The tactile picture is on the right-hand side (the house with a door and a window).
The sound buttons for the text are on the left-hand margin of the right-hand side.

Research Method

A multiple case study research method was employed as an exploratory tool to evaluate the Audio-Tactile Braille Storybook from the point of view of four blind children. My research question was: What is the verbal or emotional reaction or feelings of the cases to the different features of the book being absent or present and why?

I used qualitative data that came out of the interviews and verbal reactions of four blind children during their interaction with the book and afterwards, in their home environment. I chose to conduct the interviews in their homes because children are more comfortable in their home. If children feel uncomfortable, they become silent and it may cause loss of data (Irwin and Johnson 2005). And because using a rating scale to measure children's enjoyment and feelings had not been recommended by previous researchers (Airey et al. 2002),

The questions were unstructured, exploratory and open-ended,based on research findings and literature, to involve children effectively in the design and evaluation process of the development of the Audio-Tactile Braille Storybook and to encourage them to share their real feelings and not just what they think is the correct answer, to please the interviewer(Hanna et al. 1997).

The data was gathered in one session (main session) for each case by going to the child's home for about two hours. All the main sessions were recorded with a handy camera. The sessions were in a friendly atmosphere, where child's mother was present. The main session was held after an introductory session with the child and the child's mother to make a friendly and warm relationship with children.They had no previous experience in reading Braille books with tactile pictures.

Case reports (abridged interviews)

Table 1 gives the sex, age, degree of blindness and the current years of schooling of each case.

Table 1 Cases

Given name	Sex	Age	Degree of blindness	School
Case 1	female	7	blind, no sight	1st year
Case 2	male	9	blind, no sight	3rd year
Case 3	male	8	partially sighted, read Braille only	2nd year
Case 4	male	8	partially sighted, read Braille only	2nd year

Case 1:

She touched one of the tactile picture that was made of a piece of velvet and said, "How soft it is. I love it, I want to eat it and I want to eat it". She pushed the tactile picture and heard a wolf sound. She said,“What is this?” I told her it was wolf. She touched it and again said, "It is very soft, I like it.” She touched the tactile picture of a house that was made of scrubby paper and said," Oh! How rough it is, I do not like it" Before exploring tactile pictures she preferred to hear its sound. She pressed the picture of a cloud that was made of a piece of padding. She said,”It is a cloud" and became happy at this exploration. She pressed the picture three times and listened to the thundering and raining sound.She was opening and closing the door of the houses and also the windows. She said, "I am opening the door. I am closing the door. I am opening the window. I am closing it."

She pressed one of the buttons and said, "I love it". It was the sound of a baby crying. She pressed that button four times and listened and laughed. "I love this baby, Cute! Cute!"She played the sound of baby crying and car and rain and dog and bathing more than three times each and enjoyed them. She heard these once and said nothing. She pressed the sound buttons on a page that had a tactile picture of a house. The sounds on that page were dialogs between the old woman and her daughter and also the sounds of purring and a cricket and a door opening, and then she said," Where is the doorbell sound? I wish it had a door bell.” She played the sound of the lion for many times and imitated that sound. She was laughing and she said, "This lion is powerful. I wish this lion wouldeat the old woman.” When she reached to the page 7 (that had no sound buttons and just had brailed text and a tactile picture) she said, "This page doesn't have sound? Why? Can you put sounds on it now? I wish it had sounds. I want it. After she read page 10, her mother said that:"She, your friend Leila has come here. She shouted "Hey Leila! I will come soon". Then she said, "How many pages left? I want to listen to all sounds and then I will go". She said that she just want to press the buttons and heard sounds. She didn't want to touch other tactile pictures and read the Braille text. She said I love the book with sounds and tactile pictures.

I said, "I want to remove sounds or tactile

Case 2:

He started from the first page and listened to the sounds one by one. He was interested in talking about the sounds. When he listened to the bathing sound,he said, "This shower does not work well." When he heard the rooster sound he said,"This rooster is sick”. When he heard the sheep sounds, he said,"Thesesheep are unsettled".

He listened to the rest of sounds up to page 4. He then continued reading. He didn't care about the tactile pictures. When I remind him that there are tactile pictures in each page, he touched it quicklyand pressed it’s sound and then said, "Okay I want to go to the next page. Let's see what the sounds are". He read the text and listened to the sound buttons of the pages up to page 6 but he didn't touch any of the tactile pictures of the first six pages. Only when I remind him that there is a tactile picture in each page, he touched it very quickly. In page 7, he was exploring the page. After a few second he shouted: "It doesn't have buttons" And when I said,"This page doesn't have sound”. He said, "I am tired. That's enough for today". When I said, “Just this page doesn't have sound.” He said. "No, I am tired"

Case 3:

He started reading the Audio-Tactile Braille Storybook. After he finished the first page He said,"It is very interesting. Can I read this book again? I want to read it again tomorrow.” He kept reading until the end.

He was touching the pictures first and then he was bending his head and using his

remaining sight. He preferred to touch pictures after reading each page and listening to the sounds of the pictures. He didn't talk while exploring the pictures and hearing their sounds. He sometimes forgot to touch some pictures.

When he reached to page 7, which did not have sound buttons, he said,"Oh it doesn't have sound button? I don't like this page". He didn't miss pressing a button on any page. He sometimes pressing some buttons and he would say something. He pressed the buttons of the kiss sound three times and said, “She kisses three times”.Another time he laughed and said,“These birds are like my grandmother's birds.” He asked:" What is this?" When he heard the sounds of frog, he said, “Aha! This is frog. I had heard this in my grandmother’s house.”After finishing each page he said,“It is very interesting. It is a very good book. I love the sounds.”

Case 4:

He started reading book. He said, "What an interesting book. I had not seen something like this before. I like it. It is the best. It is my best book. Can I have it?" He preferred to touch the tactile pictures before a reading each page. He would touch the pictures first and then he would bend his head and using his remaining sight.He was asking himself, "What is this?" before he pressed the picture he would like to make a guess. "It is a dog", he said. He kept on this game until the last page of the book. He read the book up to end. He enjoyed touching pictures and making a guess. Then he pressed them and answered his question. For each picture he was asking, "It is very interesting. How did you make this picture? What is its material? It should be cloth. Oh! This one is hair. These are buttons of your previous clothes? This house has made of wood? Do you have a garden in your house? Did you make it from your trees?" He loved the telephone pictures and the car picture. He pressed each of them more than fifteen times. He pressed the telephone and said,“This telephone is cute!” And he said, "This car is very cute. Its wheels are very cute! Its sound is very cute!” During reading of the page about the telephone and the car he pressed the telephone or car picture after reading a line and when it was playing he kept reading.When he reached to page 7, which did not have sound buttons, he said,"Where are the sound buttons? It's a pity. Make sound for this one too" He said, "Can I read this book again?When will you bring it for me? I want to read it again. It is very, very interesting.”

Results

Table 2 summarizessome main results of the interviews; the cases' reactions to the tactile pictures, the sounds they particularly responded to and persistence with reading of the Braille text.

Table 2: Response to features of the Audio-Tactile Braille Storybook

Given name	Pictures	Sounds	Reading
Case 1	Soft, tough. She liked both texture and sound	baby, cloud, lion (no doorbell)	She kept reading until the end.
Case 2	He didn't touch all the tactile pictures. He was only interested in the pictures' sounds.	bathing, rooster, sheep "This rooster is sick".	He kept reading although he was tired, but only read the first 6 pages.
Case 3	He touched pictures after reading and listening to their sounds. He didn't talk. He forgot to touch some pictures.	kiss, birds, frogs. "I have heard this in my grandmother's house."	He kept reading until the end. He did not miss a single sound button.
Case 4	He enjoyed touching pictures and making a guess at what they were.	car, telephone "Its wheels are very cute!"	He kept reading until the end.

Table 3 summarizes the responses to the option of having either the tactile pictures or the sound effects removed from theAudio-Tactile Braille Storybook.

Table 3: Reactions to no sounds on page 7 and the Question (removal of sounds or pictures)

Case	Page 7 reaction	Sounds or tactile picture
Case 1	"This page doesn't have sound? Why?", "I wish it had sounds."	"I want both.", DECISION: "I will not like this book if you remove the sounds."
Case 2	"This page doesn't have sound", "I am tired. That's enough for today".	DECISION: "I want sound buttons. They are very interesting."
Case 3	"Oh it doesn't have sound button? I don't like this page".	"Keep both!", DECISION: "Sounds." "Pictures are hard to recognize."
Case 4	"Where are the sound buttons? It's a pity."	"I want both.", DECISION: "Sounds. They are amusing".

Discussion and Conclusion

The children in this study had severe visually impairments that vary in their degree and it is known that differences between the degrees of blindnesscan impact on the results (Loomis et al. 1991).Otherwise, what we understand to be true of children in general, is applicable to these children. So, what we draw from these four interviews will be impacted upon bythe age, the verbalization capability and their personality traits, such as extroversion or introversion of each child.For example, research shows that the extroversion of children may affect whether they talk about their thoughts more than introverted children (Donker and Markopoulos 2002), and other research indicates that, when reading for pleasure, there are significant differences between the reading habits of boys and girls. Girls read more for pleasure and they enjoy reading as a leisure activity more than boys (Clark and Rumbold 2006).

In general the verbal emotional reaction of all four cases was negative to page number 7. This page was the only page of the book that had nosounds. It just had a tactile picture. In all cases the children's reaction to this page supports the view that the sounds play an important role in the book.All the cases were in agreement that tactile pictures could be removed from the book and all of them were insistent on keeping the sounds in the book. They did not want the sounds omitted.Given the choice of omitting the sounds or the tactile pictures, their choice was to omitthe tactile pictures.Also all the cases showed less attention to the shape of the tactile pictures. Most of the attention was to the texture and material. Case 1:"How soft it is" or Case 4:"It should be cloth, it is wood" and cases 2 and 3 did notgive any verbal emotional reaction to the tactile pictures, in contrast totheir reactions when listening to sounds. In some cases they forgot to touch some of the pictures.

However, there are some differences in the quality of these results that can be inferred to be due to the differences between these four individuals.Case 3,in explaining his preference for the sounds rather than tactile pictures, he says that tactile pictures are hard to perceive and they need more attention. In that case the subject was partially sighted and he had an overview of each tactile picture and he could distinguished some high contrast colours and shapes. Cases 1 and 2 said that they like the sounds more than tactile pictures. Case 4 said that sounds were more amusing than the tactile pictures.Case1 did not want to read the book at first but she was attracted to the book after hearing the sound. When her friends came, she took into consideration two exciting alternatives and she had to choose which was more pleasurable for her - reading the Audio-Tactile Braille Storybook or playing with her friend. She decided that she wanted to listen to the rest of the sounds of the book before she went to play with her friend.Case 2 kept reading although he said he was tired and he stopped reading when he reached to page 7 which didn't have sounds. He also missed exploring some tactile pictures. When he was reminded of this he scanned them quickly and said: "Let's see what the sounds are." He did not miss even one sound button.Case 3 preferred the sounds because he stated that tactile perception is hard for him because he had to pay more attention to perceivethem. While case 4 was very excited about the tactile pictures and made many comments on them and had some

verbal reactions on them, he stated that the sounds were more amusing. This is also true of case 1. Although she liked some of tactile pictures and she gave some verbal positive reaction, such as "How soft it is. I want to eat it", she statedthat the sounds were better than tactile pictures.Notably, Cases 1, 3 and 4 wanted to keep both the sounds and the pictures.

The cases differed in their degree of blindness. Cases 3 and 4,who could both see large objects and high contrasting colours, tended to use their remaining sight after touching tactile pictures by bending their heads. Case 4 tended to make a guess on seeing pictures that had high contrast in their colours. For example he said: “This house is black", although it was blue.

In summary observations attributed to the similarities of the individuals were as follow:

1. Exploration of the tactile pictures was confined to exploring the texture of the materials.
2. All gave negative response to silent page 7.
3. All ultimately chose to keep the sounds but not the pictures.
4. In all cases, the sounds stimulated the children's curiosity and interest more than the tactile pictures did.

Observations attributed to the individual differences between the cases are as follows.

1. Case 2 was induced to continue reading by the pleasure of the sounds.
2. Case 3 found sounds more pleasurable than perceiving tactile pictures.
3. Case 4 and Case 1 enjoyed the texture of the pictures but the sounds were more important than texture in inducing pleasure.
4. Case 3 and Case 4 needed to use their remaining sight to assist in their perception of the pictures.

Conclusion

My overall conclusion is that although both sounds and tactile pictures were two important features that induce pleasure in some cases, sounds, in comparison to tactile pictures, were found to be significantly more effective in inducing pleasure in the blind or partially sighted children who were the cases of this study.

Further research suggestions:

1. This preliminary study could be extended by interviewing other blind children and developing other Audio-Tactile Braille Storybooks.
2. This research can be done with other research methods and analysed quantitatively to test the validity of the conclusions of this study.

Limitations

This research had some limitations as follow:

1. The sample size was small and cannot be representative of the entire community of Iranian blind children; four interviews from one source cannot be generalized to all blind orVI children.

2. The low level of ability of cases to recognize and portray their feelings towards their reading ofthe Audio-Tactile Braille Storybook due to their age and their disability.

3. The Audio-Tactile Braille Storybookthat I designed and fabricated was not a fully interactive e-book. It was a makeshift prototype. Only the audio feedback (the sound buttons) were under the control of the users.

NB The tactile feedback of the Braille text and tactile illustrations was deliberately chosento be static, because I wanted to use the low cost and accessible technology that existed in Iran.

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