Impact of Haptic Feedback on Parent-Child Interaction During Story Time

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ABSTRACT

It is important for children to have development in literacy at an early age. Currently, researchers are exploring ways to strengthen children's engagement with stories through electronic storybooks (ebooks). This paper discusses the impact of haptic feedback on the interaction between parents and children during story time. Studies show that increases in engagement have a positive impact on the comprehension of the story that was read. In this paper, we discuss two experiments. One looks at how parents and children use haptic feedback to express their own individual understanding of the story. The other examines the influence of haptic feedback on the interaction between parent and child when reading a story together. We see that children respond positively to the feedback and that parents do in fact play a role in the level of impact on the child's literary understanding. Results also showed a positive impact on engagement from both parents and children, making the reading experience more enjoyable for both persons in the group.

Keywords

Haptic, Haptic Feedback, Electronic Storybook, Parent-child Interaction, Story Time

1. INTRODUCTION

When it comes to reading, we have the option of using a printed version of the text or using an electronic copy of the text, commonly known as an ebook. Ebooks allow readers to access features such as interactive activities, accessing definitions, and saving and highlighting portions of the text. Through the use of tablets, we are able to use ebooks on the go. Currently, there are studies being done to explore the capabilities ebooks have in regards to providing different types of feedback to enhance the user's reading experience.

Studies show that the level of engagement in reading has a significant role in the readers' comprehension of the text [5]. Comprehension of text improves as frequency of reading and level of engagement with the text increases (Cipielewski & Stanovich, 1992, as cited in [5]). When it comes to reading by children, there are studies that show a positive correlation between the engagement the child has in the text and the comprehension of the text. Another factor that has been shown to have a positive impact on the literacy development of children is the amount of engagement the parent has when reading text to their child [2].

Through the use of haptic feedback, researchers aim to create a more engaging experience that allows the parent to guide the child through story time in order to keep the child engaged and also enhance the level of comprehension of the text. However, there is still much to be learned in regards to what type of haptic feedback can be provided. With current technology, the different types of sensations the device is able to send are limited.

In this paper, we will look closely at an experiment that explores how parents and children use haptic feedback to express their interpretation of a story. From there, we take a look at how parents narrate a story to their children while using haptic feedback as a supplemental resource. We conclude with a discussion of the two experiments and a conclusion section of what we are able to gain from looking at them together.

2. BACKGROUND

2.1 Haptics and Haptic Feedback

Haptic technology is interacted with through touch. There are haptic technologies that are hand-held, like smart phones and tablets. There are also wearable haptics, like the FeelSleeve [7] that we will take a look at in the next section.[1]

Haptic feedback is the response the device sends to the user when interacting with the device. We commonly encounter haptic feedback through cellular devices when we receive vibrations as feedback to signal a change in the system a specific way. As we will see in the experiments that will be the focus of in this paper, friction is another way that haptic feedback can be created [3, 4].

2.2 Related Work

There are recent studies that have been done to analyze children's interaction with ebooks that provide haptic feedback. One piece of haptic technology developed is a type of wearable technology called the haptic vest [8]. The haptic vest is a vest that has small devices built in that sends vibrational feedback to the user. In the experiment, a child was given a haptic vest, iPad, and headphones. On the iPad was an audio story. As the child would listen to the story, the vest would send vibrations to the reader based on the events in the story. For example, if there happened to be rain happening in the story, the vest would send a vibrational pattern to simulate the sensation of standing in the

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Figure 1: A child reading with FeelSleeve and feeling haptic effects associated with story events on her hands & a front view device. [7]

rain. [8]

Another piece of wearable technology developed is called the FeelSleeve [7] (see figure 1). This piece of technology is a rubber covering that goes around the back of a tablet. Attached to the backside of the cover are gloves that the user can slip their hands into. While reading the story, the child has their hands in the glove. There are actuators between the glove and the rubber covering that sends vibrations to the hands of the user based on the designated haptic feedback integrated into the story, thus sending the sensations to the child. Results showed that the feedback helped make events in the story more recallable, and also that the feedback enhanced the understanding of the story. [7]

Though there have been quite a few studies done in regards to wearable technology and haptic feedback, it wasn't until recently that research has been done in developing feedback through the tablet alone. This sparked the development of the Tactile Pattern Display, or TPaD [6] (see figure 2). The TPaD is a device that has a transparent glass screen that covers the screen of a tablet. When connected to the tablet through circuitry, the TPaD changes the friction on the screen to send different textures of feedback to the user when touched with the tip of their finger. The experiments described in later sections of this paper use the TPaD with the Google Nexus 7^{tm} tablet.

3. HAPTIC FEEDBACK & INDIVIDUAL UNDERSTANDING OF TEXT

3.1 Method

In this study, researchers take a look at how parents and children may use haptic feedback to show their understanding of the events in a story. In this experiment [3], ten pairs of a parent and a child were selected. Ages of the children ranged from 3 to 8, with there being 5 females and 5 males. The experiment was held in a research lab that was styled with furniture to bring a "family living room" atmosphere to the pairs. All of the children chosen for the experiment were familiar with how to use a tablet from activities such as watching movies, playing games. Only one parent out of the ten pairs had prior experience with using a TPaD Tablet.

Before starting the experiment, each parent-child pair were led through a period of training to get them used to using the TPaD Tablet, along with adjusting themselves to the different sensations the display would give off. Next, the children and parents were given time individually to use the tablet with its authoring system, which allowed them to place haptic feedback into the e-book story based on their own interpretation of the story. In the application, they are given a pallete with different feedback textures (bumpy, rigid, etc.). To place the feedback into the story, they would select the section in the story they desire to place feedback and draw the texture in with their finger. [3] (see figure 3) The purpose of separating the parents and children was so that the researchers could analyze the practical and conceptual differences between how they interpret the story based on their own understanding of the events.

The experiments were recorded by video with transcriptions, and also by log file data from the tablet. Everyone was given the same six pages from the same ebook, "Clifford Helps Out", which was recommended for children in pre-K to grade 3 (ages 4-9).

3.2 Results

When interviewing the parents and children after the experiment, there was a noticeable agreement between them in regards to how engaging and enjoyable it was to have haptic feedback integrated into the ebook. The child from pair 9 (age 6) stated that the textures were "fun to feel." There were two children that pointed out that one way they determined where to place feedback was based on objects that they knew shouldn't be touched in real life, like a fire. The child from pair 1 noted that, in terms of the reading experience, adding the feedback "can help kids understand if they can't read the words." [3]

Many of the parents involved in the experiment thought that incorporating haptic feedback would really help enhance the reading experience. They expressed that the strategy they used when placing the haptic textures was based on how it would help their child understand the book. The parent of pair 8 stated "It would make the book more fun to have the textures..." and "more interactive and more playful..". One important bit of information to point out that some parents did acknowledge a flaw, which was the fact that there are limits to the textures you could feel from haptic feedback versus the textures you could feel from a physical book. A comment from the parent of pair 7 was "I don't think it replicates a fuzzy lion's tail or shiny butterfly", pointing out the limitations of the types of haptic feedback sensations currently achievable. [3]

One important suggestion that the researchers discussed

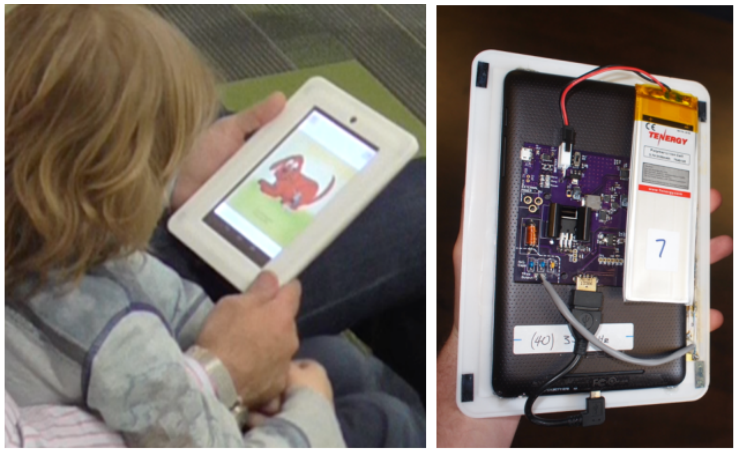

Figure 2: Left: TPaD Tablet device. Right: tablet mounted with circuit board, actuators, and battery (back cover removed). [6]

Figure 3: Left: Texture palette in e-book authoring application, users "paint" haptic patterns onto pages of an e-book, with black areas assigned high friction and white areas low friction. Right: Child (age 4) feels haptic textures on e-book pages [3]

in the paper is to consider actions or emotions (for example, using a "bumpy" texture on a character to mimic goosebumps from being afraid) when designing haptic ebooks. Results from the experiment showed that parents would use haptics to express an action or an emotion. However, this was believed by the researchers to be too abstract of a use of haptics for children. Hence, the children would need guidance on how to use the feedback in this way.

4. HAPTIC FEEDBACK & PARENT-CHILD INTERACTIVITY

4.1 Method

The second study we will discuss takes a look at how haptic feedback influence the interaction between parents and children during story time. In this experiment [4], 18 pairs of a parent and a child were selected. Ages of the children ranged from 4 to 7, with there being 7 females and 11 males. The pairs were split up into two different condition groups: 9 in a haptic ebook condition and 9 in an non-haptic condition. All of the children chosen for the experiment were familiar with how to use a tablet from activities such as watching movies or playing games. One parent had very minimal experience with using a haptic tablet, while the others had none at all prior to this experiment. Parent-child pairs in the haptic ebook condition were allowed 5-10 minutes to get adjusted to the functionality of the tablet.

Each pair was given the same ebook, "Clifford's Good Deeds", which was recommended for children in grades pre-K to 3 (ages 4-9). The researchers themselves added the haptic feedback to the ebook based on their collaboration with a research team from child development and surface haptics. "We added haptic feedback throughout each page, such as on Clifford, other objects in the scene, the background, and motion lines..." [4] (see figure 4).

The groups were instructed to read the story as they would if they were reading at home. Following the reading, they were asked individually to answer a series of questions using the Likert-style attitude statements (5-point scales; 2 = "strongly like/agree" and -2 = "strongly dislike/disagree"; smiley/frowny face scale for children) (see Table 1), along

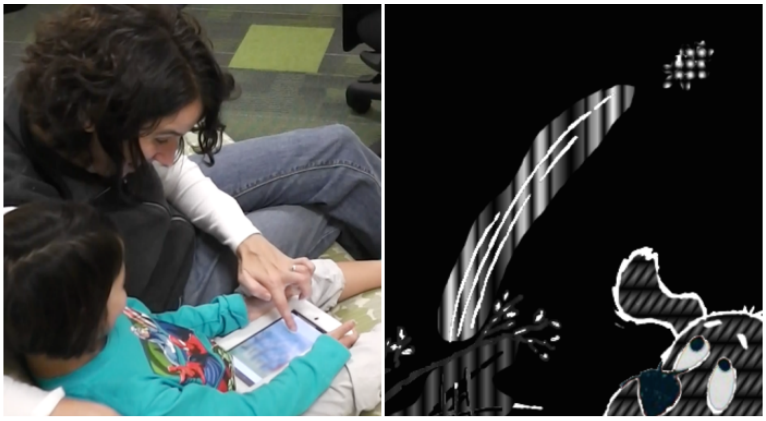

Figure 4: Haptic e-book. Left: Parent points towards a cat flying in the air and says, "What happened?" to which the child responds by feeling the textured motion path. Right: Haptic rendering of book illustration (motion path with flying cat) [4]

with some open-ended questions based on their experience of the experiment.

2	Strongly Like/Agree
1	Like/Agree
0	Neither Like/Agree
-1	Dislike/Disagree
-2	Strongly Dislike/Disagree

Table 1: Rubric for Likert-Style Attitude Statement Responses

The experiments were recorded by video with transcriptions, and the researchers coded data taken from analyzing the interactions between the parent and child. The researchers coded the data by looking at different traits of what was being said by the parents and the children. They took note of the type of utterance (for instance, if what was said was a question or a statement), what the focus of the statement was (i.e., story content or feedback from the technology), and if what was said was to express an event, action, or emotion in the story (i.e., making sounds to represent the bouncing of a ball). Table 2 provides a more detailed list of how that data was coded along with examples of specific statements that were coded in each way.

4.2 Results

The researchers used a series of Mann-Whitney U-tests to compare the different interactions the pairs had in the two condition groups. It was noticed that there was not a significant time difference between the amount of time each parent-child pair spend reading the ebook (M(haptic)=373.33 seconds (SD=136.30); M(non-haptic)=303.00 (SD=101.84)). There was a similar rating overall between the children in the haptic and non-haptic condition group in regards to how much they enjoyed the reading (haptic: M=1.22, SD=.97; non-haptic: M=1.44, SD=.88). The same is noticed with the parents in each group (haptic: M=1.11, SD=.78; non-haptic: M=.67, SD=.87).

When looking at technology-related talk, parent-child pairs in the haptic condition group had significantly more (two times more) talk related to technology than pairs in the non-haptic condition group (U=15.5, p=.02; M (haptic)=18.78, SD=9.44; M (non-haptic)=7.78, SD=7.03). 93% of technology-related talk in the non-haptic group was based about turning pages in the ebook, whereas the haptic condition group spoke on page turning only 31% of the time. When sorting the data, the researchers separated what was being said by the participants into three categories: questions (40), answers/explanations (39), and statements/comments (39) made about the textures on the page.[4]

When looking at the amount of technology-related talk in the haptic group compared to the non-haptic group, the researchers looked at technology statements/comments (U=1.5, p<.001; M (haptic)=5.67, SD=1.93; M (non-haptic)=1.00, SD=1.32), technology-related questions (U=13.00, p=.01; M (haptic) =4.44, SD=4.10; M (non-haptic)=.78, SD=.97), and technology-related answers and explanations (U=16.00, p=.03; M (haptic)=4.33, SD=4.61; M(non-haptic)=.44, SD= .73). From looking at the coding, the researchers could see that the haptic feedback in the ebook was used by parents to assist them in narrating the events in the story. They would also use the feedback to discuss concepts or actions that occurred in the story (dry leaves making Clifford sneeze) [4].

In terms of expressiveness, parents incorporated much more of it than the children. It is recorded that there were only 3 occurrences of children contributing expressiveness across the two condition groups. The parents in the non-haptic condition used 4 times as much expressive behavior as the parents in the haptic condition, whether it was verbal, words that describe the action of an object (i.e., "boinga, boinga of a ball), or gestures [4]. There were instances where they would make gestures to depict certain actions in the story, like the flying of a plane, or Clifford moving [4]. Parents in the non-haptic condition felt a greater need to express moments in the story themselves, which makes sense since those in the haptic condition had feedback from the story as a great assistance.

Parents in the haptic condition felt as though the feedback included in the ebook would make the experience more "fun". One parent stated, "We definitely spent more time looking and studying the page. I think we also spotted more details in the illustrations." There were other parents that felt as though the feedback textures helped reveal more infor-

First Level: Type of Utterance
Statement/Comment: declarative utterance ("Oh boy, Clifford!", "He got a little nervous.")
Directive: telling partner to do something ("Look at the woman.", "Touch the cat.")
Question: interrogative utterance directed at partner ("What happened?", "What is he doing now?")
Answer: verbal response to question directed at partner ("I don't know.", "Probably disappointed, too.")
Second Level: Object of Statement
Story Content: talk about elements of the story or narrative ("Clifford wants to get the kitty.")
Reading Experience: talk about reading in general, not specific to story (sounding out words, "Sit next to me.")
Technology: talk about the tablet computer or haptics ("Do you want to touch it?", "Look at the screen.")
Third Level: Verbal/Nonverbal Expressiveness
Expressiveness: purposeful addition of verbal or nonverbal elements to enhance story (intonation changes, sound effects, "boinga, boinga", gestures)

Table 2: Coding scheme for parent-child interaction [4]

mation about the story and helped the kids focus more on what was going on in the events of the story. One important statement one parent made was that the haptic feedback was "just another sense that they're getting and something that's stimulating them when they're reading and helps them remember". This puts a bit of emphasis on the goal of using haptics to help engage children with what they are reading. [4]

5. DISCUSSION & CONCLUSION

In this paper, we described details of two studies [3, 4] using TPaD technology, which builds on previous studies of haptics for children. Study one [3] examines the different ways parent and child would interpret and narrate the story on their own using haptic feedback. Study two [4] examines the impact of haptic feedback during story time between parent and child. Looking at the results of the study, we can gather that:

- Parents see haptic feedback as a helper in narrating the story: When designing the story, the parents would use the feedback to express actions or emotions of the characters and objects [3]. When in story time, parents often didn't feel a need to express these moments themselves because they felt that the feedback expressed the events well enough to guide the child through the story [4].
- Parents tend to have a more abstract understanding of how to use haptic feedback to tell a story: Children incorporated only about half the amount of haptic feedback textures to the story than the parents (U = 3.25, p = .001, M = 1.62, SE = .16). However, the parents would use the textures in more complex way than children. For instance, a parent applied a texture to a ball because the texture "felt like the grip on the basketball". [4]
- Haptic feedback has a positive impact on the experience for both parents and children: Both studies report positive reports from the parent and child in regards to how enjoyable and engaging the story was when the feedback was involved. This would lead to an increase in engagement for both parties, in turn having an impact on the child's comprehension of the text.
- There's no clear evidence that pushes for haptic feedback in ebooks: Even though we could see how parents used haptic feedback as an assistant to help lead story time, there's no clear-cut evidence that leans towards it being a vital tool. Children would respond well to the expressiveness of parents as well as the haptic feedback. Study two [4] showed us how parents would design a story to help their children understand it. We could see in study one [3] that many parents were able to illustrate many actions and concepts themselves without the feedback. It appears that it may depend on what method the child has a greater interest in. If a child responds better to the interaction with the parent, then that may work better for story time.

It is evident that parents play a role in the engagement of their children during story time through narration. Whether that is with their own expressiveness or with the assistance of haptic feedback, the way they express ideas and ask questions that guide the child through the story is vital in the experience. Allowing parents to design the haptic feedback may enhance this even greater by using their abstract ideas of where to place the feedback to guide the way the child thinks about the story. As we seen in the first study, asking the child questions about how the feedback feels and what they think of the events pushes them to vocally express their thoughts.

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