Autonomous Sensations: Senses Stimulating Toy for Autistic Children

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ABSTRACT
This paper presents the design process for a playful experience that stimulates the tactile sensation in autistic kids. The design of the toy followed a process in which there were two types of design constraints. The first type of constraints focused on the needs of autistic kids and making sure the design is incorporating those requirements. The second type of constrains was imposed during the second phase of the design process, in which the toy was designed under the lenses of play to provide a playful experience and insure the effectiveness of the design decisions that were implemented.

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Toys, Tangibles, Autism, Touch.

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User

Interfaces—Haptic I/O, User-centered design

INTRODUCTION
In order to manifest an environment that is conducive of positive behaviors, one must think about opportunities that create a range of catalysts for a child to experience. Our toy begins to explore the reasoning that occurs between senses of touch and visual stimuli. The relationship between the two creates a sometimes difficult lapse in judgement in children with autism.

The prototype uses a variety of surface textures and depths in order to allow for a wide range sensation to occur. Augmenting the material inside of the prototype will lead to the stimulation of light. In this instance both light and touch will lead to a visual display that will trigger further investigation into the toy. The lights will be the ultimate reward of playing with the toy meanwhile the textures will complement the ongoing sensations. The result of using such a toy will allow for the children to begin immersing themselves in an environment where they can coexist with various senses.

RELATED WORK
In order to better understand the research domain and before diving into the specifics of the proposed design it is helpful to give some context by providing related work and some literature review to explore the different aspects of autism and design.

Squeeze and Deep Pressure
Squeeze Machine is a system used to stimulate deep senses of touch and pressure which produces a calming effect on autistic individuals. A person could be positioned inside the machine with their feet and head outside, and then pressure will be applied on the sides of the body inside the machine. The amount of pressure and the position of the person inside the machine could be controlled and adjusted depending on the need of the individual. [9]

Based on research studies conducted to observe the effect of pressure and the squeeze machine, it has been proven that such experience provided a positive effect for individuals who used the machine. It has been noted in one study that children who received pressure from the squeeze machine had their anxiety and tension level significantly reduced after using the machine. [8] It has also been observed that the effect of light touch and deep pressure is quite the opposite when it comes to the nervous system. Applying more force to touch or deep pressure is more relaxing than a light touch on the surface of the skin. [4]

According to Temple Grandin the designer of the system, the ability to control the amount of pressure applied helped transform the touch and pressure experience from anxiety inducing into a relaxing one. Based on her own experience using this machine and applying continuous pressure on her body provided her with the ability to touch others including her cat without repelling [4]

Tangibles for Children
Research done in the field of tangible interfaces design has proved the effectiveness of using such interfaces to create a rewarding experience for children. Development psychologists believe that tangible interfaces provide the best learning experience for young children during their development process. Tangible objects allow children to have a physical direct interaction with objects which triggers their curiosity to explore and engage with the object in hand. Play as a process in which children interact with objects is important for their development. Those objects could be simple toys such as dolls and small cars and building blocks. [7]

The properties of tangible objects provide a richer environment to utilize by designers to create a learning experience superior to regular learning experience using non-tangible interfaces. Texture, color and weight are all features of objects that could trigger kids' curiosity to explore and immerse with the physical object. Tangible interfaces and objects are easily perceived through kids' proprioceptive and haptic senses. The physicality of the object allows more properties to be added to the experience such as instant feedback. The actions performed and the feedback given as a response triggers the sense of exploration in kids. This natural interaction provides a more intuitive and engaging experience for children with learning disabilities such as autistic kids. [5]

AUTISM AND DESIGN CONSTRAINTS

Autism is a disorder that affects the person's social interaction, communication abilities and behavior. For the scope of this paper, autism also affects the ability of autistic children to play like other kids. It has been observed that autistic kids have problem understanding imaginative play or group play. In terms of sensation, they are also very sensitive to light and loud noises or rough textures. [3]

Autistic children have difficulties responding to auditory and visual input. Sensory simulations like touch and proprioceptive input are more preferred by autistic children over vision or hearing. Autistic children tend to spend more time on a tactile exploration task than they do on visual tasks. [6]

Based on the previous description of our target users, we have developed the initial constraints of our design. The proposed design will provide a subtle experience in which no intense light, sound or texture is used.

THE TOY

The prototype of the toy uses different textures and depths to stimulate the haptic and proprioception sensory. The material inside of the prototype will invite the kid to explore the toy by squeezing in and touching the different surfaces. The immersing experience of touch and pushing will stimulate the feedback provided from the toy by producing subtle light beneath the internal material. In this instance both light and touch will lead to a visual display that will trigger further investigation into the toy. Only white was used in this toy as the color of the internal material to avoid any over sensations and stimulation of the visual sensory. In addition, the decision of keeping the color of the toy light and subtle is to minimize and guide the interactions and stimulations of the experience. The toy is heavy enough to be held and felt, multi-surfaced to be touched and squeezed, equipped with light to give feedback and act as a reward system for the playful experience. (Figure 01)

Figure 01 A prototype of the toy during the second feedback session

DESIGN PROCESS

The design process of the toy went through three phases. The first phase was an initial step to get the team started by brainstorming ideas and decide on the preliminary score of the toy. The other two phases were focused on designing the playfulness aspects of the toy and the physical properties.

First Design Phase

The design process followed was iterative in which we started by brainstorming and sketching multiple ideas that take into consideration the general requirements to design objects for autistic children, like for example their high sensitivity to light and sound (see figure 02). After multiple iterations we decided to focus our attention on designing a toy.

FIGURE 02 Sketches of some of the initial ideas in design phase 1

Toy Design

Children in general tend to enjoy playing with toys. This playful environment provides an attractive field for

designers to provide an experience for kids that could improve their skills while enjoying their time. There are many forms of play and for the scope of this paper we focused on designing an experience that takes into consideration some design constraints to accommodate the needs of autistic kids.

To provide the right sensory experience for autistic kids, the toy has to incorporate small motor skills in order to allow them to practice their haptic skills and intrigue their curiosity to explore. In order to create a common ground amongst the design team our initial brainstorming process started with indicating the most desirable aspects in our toy that we want to convey. We followed the mechanics, dynamics and aesthetics (MDA) model. [1] For aesthetics the toy should provide discovery, touch and curiosity. For mechanics the toy should have the right weight to be carried around and played with, include different material to explore and stimulate the sense of touch. For dynamics the toy could be squeezed, pressed and rotated and feedback will be provided to give some structure to the gameplay but the kids are free to explore the object and apply their own rules.

Second Design Phase

During this phase design decisions were implemented using the lenses of play. This method was useful in providing a clearer picture of the main design decisions that we wanted to implement in our toy. The Lenses of Play is a design toolkit that helps designers focus on certain perspectives when developing a playful experience. [2]

For designing the toy, at the early stages we followed an open-ended play approach in which the gameplay is unguided and there is no end goal. As we started iterating through the sketching process we decided to apply another lens of play that focusses on the stages of playful interaction. The stages are as indicated in the following diagram (see figure 03). The playful experience starts with the inviting shape of the object, which doesn't have a definitive shape and is encouraging to be held not just observed on another surface. The different materials used encourage exploration, and providing some visual feedback will create an immersive experience to the child with some direction in the gameplay. The different materials used also encourages squeezing which triggers exploration and immersion into the experience.

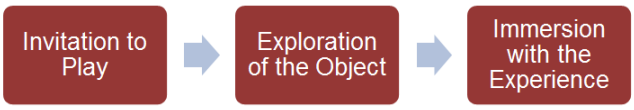

Figure 03 The 3 stages of playful interaction

Third Design Phase

In this stage the initial prototype of the toy was shared with other designers and researchers in the field of interactive interfaces for autistic children. The invitation to play that was sent from the toy was clear and other designers started squeezing and playing around with the toy. Positive feedback was also received regarding the weight of the toy which was used to trigger the sense of proprioception of autistic children to give them better registration of their physical location and space. One concern was raised regarding the colors we used in the prototype and the feedback. The colors were 2 bright colors and that prevented the light feedback to appear clearly as the visual stimuli. Therefore, for our prototype we decided to use white as the color of our material to simplify the visual feedback and isolate the sensations.

PROTOTYPING PROCESS

The form of the toy was conceived using Maya, animation software often used to create animated movies in the film industry, such as Pixar movies. We used the software to create a form that was easy to hold in the hand but offered a range of depths and curves. This would create an object that felt more natural in the hand. The rigid layers were then added to the model to create the desired texture we wanted the user to experience. We then created separate layers for each level of the model to cut individually on the laser cutter machine using foam core to re-create the model created in Maya. This model was then used as a mold for the "Vacuu-form" machine (figure 04) which takes forms and molds them out of vinyl. The model is depressed onto the melting plastic to create the desired form with ribbed edges now onto plastic.

Figure 04 The mold during the prototyping process in the Vacuu-form machine

After this, we cut the plastic form onto a rectangular sheet in order for it not to remain a flat plastic mold on the edges. Once cut we used a heat gun to melt another piece of plastic to wrap onto the back of the object. Once finished the

material was submerged into the mold to create the final toy.

CONCLUSION

Autistic kids are characterized with difficulties in their communication and interactions. They tend to respond more efficiently to proximal senses like touch and proprioception more than distal senses to process information like vision. In this paper we discussed the design of a toy that triggers their sense of curiosity to explore different materials and visual stimuli and will trigger their senses of touch and proprioception. The mass of the toy help the kid register his/her physical location in the environment and encourages the activity to hold and explore. The different material in the toy invites the child to apply pressure which was proven to provide a relaxing experience for autistic kids. The design process followed an open-play approach in which the rules of the play are invented by the kid playing. In addition the play experience provided a three stages for the player starting from the undefined shape that invites the player to hold, the different material that triggers the sense of exploration and the light which provides a feedback once the child is immersed in the game.

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REFERENCES

1. Bekker, Tilde, Ben Schouten, and Mark de Graaf. "Designing Interactive Tangible Games for Diverse Forms of Play." Handbook of Digital Games (2014): 710-729.
2. Bekker, Tilde, Linda de Valk, and Berry Eggen. "A toolkit for designing playful interactions: The four lenses of play." Journal of Ambient Intelligence and Smart Environments 6.3 (2014): 263-276.
3. Blachford, Stacey. "The Gale encyclopedia of genetic disorders." (2001). p130-134
4. Grandin, Temple. "Calming effects of deep touch pressure in patients with autistic disorder, college students, and animals." Journal of child and adolescent psychopharmacology 2.1 (1992): 63-72.
5. Marshall, Paul. "Do tangible interfaces enhance learning?." Proceedings of the 1st international conference on Tangible and embedded interaction. ACM, 2007.
6. Masterton, B. A., and G. B. Biederman. "Proprioceptive versus visual control in autistic children." Journal of Autism and Developmental Disorders 13.2 (1983): 141-152.
7. Revelle, Glenda, et al. "Tangible user interfaces for children." CHI'05 Extended Abstracts on Human Factors in Computing Systems. ACM, 2005.
8. Stephen M. Edelson, Meredyth Goldberg Edelson, David C. R. Kerr, Temple Grandin; Behavioral and Physiological Effects of Deep Pressure on Children With Autism: A Pilot Study Evaluating the Efficacy of Grandin's Hug Machine. Am J Occup Ther 1999;53(2):145-152. doi: 10.5014/ajot.53.2.145.
9. Volkmar, Fred R. Encyclopedia of autism spectrum disorders. Springer, 2013.