STUDY OF THE EXPERIENCE OF CHILDREN'S TOYS FOR LOW-VISION AND BLINDNESS

GUIDELINES FOR DESIGNING AN ENJOYABLE TOY FOR VISUALLY IMPAIRED CHILDREN WITH THE GOAL OF AIDING IN VARIOUS AREAS OF THEIR EARLY CHILDHOOD DEVELOPMENT

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PAPER ABSTRACT: This study examines ways to design better experiences for children's toys for those with low-vision or blindness in an educational setting. Children with visual impairments often have difficulty interacting with traditional toys, which can impede their learning and development. By designing toys that are accessible and engaging for children with visual impairments, industrial designers have the potential to greatly aid these children's learning and development. Strategies to make toys more accessible for VI children include incorporating tactile features, utilizing audio cues, and providing braille labeling. Previous studies have emphasized the importance of considering a child's input when choosing a toy, and the role of adults in selecting toys that align with their values and promote learning. Additionally, designers can investigate new technologies like haptic feedback and voice recognition to create a more immersive and interactive experience. Sound augmentation is another avenue that can be explored for designing educational toys for children who are blind or have low vision. In addition to the results of literature review, the data from user interviews is presented in this paper to address the needs of the target users. This study highlights the importance of considering the needs of children with visual impairments and the opportunities for industrial designers to create innovative, fun and educational solutions.

Keywords: Blind, Vision-Impaired, Visually Impaired, Toy Design, Inclusive Design, Augmented Toys, Children with Visual Impairments, Learning, Playful Learning, Audio-Tactile, Multi-Sensory, Autonomous Play, Play Tools, Early Childhood, Social Interaction, Social Play, Music Therapy.

1. INTRODUCTION

Edutainment and playful learning methods have been used in schools and by parents to aid in childhood learning. Children with visual impairments (VI children) need more thoughtful toys that they can enjoy but that also help them developmentally. VI children often have developmental delays (Verver, 2020, a), so there is a great need for the creation of more toys as developmental tools. Areas in which play can aid in childhood development include:

- Speech and language,
- Cognitive and intellectual,
- Social and emotional, and

- Fine and gross motor.

The purpose of this literature review is to gather criteria for toys specifically tailored to visually impaired children that will aid children in various areas of their early childhood development. This includes social and emotional, cognitive, spatial and motor, and language development.
This review also investigates how multi-sensory experiences can improve engagement and comprehension when utilizing such educational tools. Providing criteria and background to help designers produce artifacts specifically designed for the VI children will lead to higher levels of social inclusivity and help be preventative of various developmental delays that visually impaired children face due to a lack of proper enrichment in their early childhood. Methods for gathering this criterion include the use of databases available through [University Name Redacted] Libraries to conduct secondary research. Keywords used include Blind, Vision- Impaired, Visually Impaired, Toy Design, Inclusive Design, Augmented Toys, Children with Visual Impairments, Learning, Playful Learning, Audio-Tactile, Multi-Sensory, Autonomous Play, Play Tools, Early Childhood, Social Interaction, Social Play, Music Therapy.

1.1 RESULTS
Through the systematic search of academic databases utilizing identified keywords, 8 themes emerged: importance of early childhood development, challenges in accessing tactile toys and spatial awareness toys for vi children, orientation and mobility, social development, sound- augmented toys to encourage peer-play, music therapy in early childhood, toys as educational tools, and toys for expression and multi-sensory stimulation.

Importance of Early Childhood Development:
Deficiencies in one or many of these areas can lead to socio-emotional and behavioral issues (Verver, 2020, a). On the other hand, children and adolescents with visual impairments that experienced sufficient development in those areas in their early childhood are better equipped to be autonomous and self-reliant in adulthood. Regardless of the developmental issues they face, visually impaired children are entitled to the same basic experiences of childhood that sighted children have such as enjoying play and learning. Providing educational toys that are designed from the beginning for them instead of adapting toys improves the quality of their learning and can prevent developmental delays. Educational toys can also encourage visually impaired children to pursue learning opportunities and explore their surroundings, which greatly improves their confidence and autonomy.

There are quite a few sound recording toys for children, but many of them rely on visual signifiers to differentiate what each component does. Other barriers may arise in toys that are not designed with blind children in mind from the beginning, but toys that include braille are more expensive and harder to find. For tactile toys, there are already many for blind and sighted children alike to enjoy. When it comes to toys to help children with their spatial awareness and mobility, this area is lacking. Apart from the novel ABBI (Finocchietti, 2015), a wristband device that is designed to help the visually impaired with

spatial awareness by giving audio feedback to body movement. The 2015 pilot study on the device found that children were able to improve their spatial and mobility abilities significantly. While promising, this device is available primarily and Europe and is still not widely accessible.

Orientation and Mobility:
Something that hinders the development of a person with visual impairment at any age is difficulty with spatial awareness. The better their understanding of the space they occupy, the more confident and autonomous they can be. It's also very much a safety issue, so the goal is to enable them to handle day-to-day activities in a self-sufficient manner. Orientation and mobility will give children the confidence to participate in play activities that require gross motor skills (Ablan, 2019), which can help them engage with sighted peers and further develop their social skills (Verver, 2020, b).

Social Development:
One of the areas children with visual impairments struggle the most is with social participation. They do not have the ability to assess expressions and body language cues in peers, which leads to large gaps in understanding between differently sighted children (Verver, 2020, a). Early social interaction and positive bonding patterns should be established as early as possible (Metell, 2015), to help them avoid potential behavioral issues in the future. Since the primary sense used for socialization is sound, the use of sound-augmented toys and music therapy is often proposed to encourage visually impaired children and adolescents to be open to new social interactions or new sound environments (Verver, 2020, a).

Sound-Augmented Toys to Encourage Peer-Play:
Sound can help encourage children with lower levels of sociability by giving them and their sighted peers an experience that encourages joint attention (Verver, 2020, c). The sound also helps VI children track the interactions of their sighted peers, which is needed to maintain proper peer play. However, in VI children that are already more social, the sound-augmented toy may lower cooperative play and increase parallel play (Verver, 2020, c). Parallel play typically occurs at the introduction of the sound-augmented toy because VI children need a longer exploration period before being willing to engage in peer play (Verver, 2020, b). There also appears to be a ceiling effect to this method of trying to encourage peer play with children of any social ability (Verver, 2020, c). These findings suggest that although some children may be enabled to socialize with their peers, they may still choose not to. This suggests that encouraging socialization in children at a younger age is very important.

Music Therapy in Early Childhood:
Music therapy has been used to encourage positive bonding patterns between VI children and their caregivers. This contributes to their early social interactions but has the potential added benefit of culture acquisition (Metell, 2015). It was previously discussed in this paper that sound-augmented toys do not fully succeed in encouraging or improving the quality of social interaction. With music therapy, it has been observed that responsiveness and social intimacy are encouraged (Metell, 2015). An example

of this introduced from the study is how the rhythms experienced through music help children understand the concept of synchronization with another person. It also helps with their confidence and social development through personal expression and participation in joint attention. In this study, one method of joint attention was expressed through touch.

Another benefit of music therapy for VI children is how it can help improve their relationships with sounds. Many children have aversions to loud or strange sounds, but music therapy can help them be calm in different environments through exposure to a variety of novel sounds (Metell, 2015). With this enjoyable sound exploration, they are more likely to gain a better understanding of the spaces they are in and may be encouraged to engage with items to investigate their effect on the space by making noise with them (Metell, 2015). Caregivers can take the music outside of the therapy setting by using music in daily life to help children fulfill activities throughout the day in a calmer manner (Metell, 2015).

These observations contribute to how music therapy can be very beneficial in overall confidence. It is an empowering experience that helps them develop their intrinsic motivation formation (Metell, 2015). IMF includes motivations such as autonomy, mastery, and purpose. Improved IMF helps with their motivations to do an action with internal rewards (Metell, 2015).

Toys as Educational Tools:
Play is enhanced with audio feedback (Verver, 2020, a), so it is not that sound-augmented toys do not have any success, they just have been shown to be more successful for individual play in educational settings. Playful learning should be used in addition to more traditional learning methods to aid in retention (Verver, 2020, a), because repetition helps with memorizing factual knowledge (Ablan, 2019). Sound-augmented toys give the child the ability to repeat facts as much as they need and can also be used to encourage auditory analysis by playing sound- guessing games. These games can help VI children understand different objects, contexts, and events (McElligott, 2004). With any new object, comprehension occurs through encouraged exploration and adequate time to explore (Verver, 2020, a).

Toys for Expression and Multi-Sensory Stimulation:
Multisensory experiences are very good for children who lack one of their key senses; they enjoy the stimulation when they are under-stimulated in one of their senses (McElligott, 2004).
Observations of VI children have suggested that inter-sensory relationships can help them express ideas. For example, certain textures are associated with different emotional experiences (McElligott, 2004). In addition to this, tactile modeling is a critical way for children to participate in object exploration (Ablan, 2019, Verver, 2020, b). Toys that allow them to pick sound effects, record sounds themselves, alter the sound of their voices, mix, and edit audio, are great for creativity and self-expression (McElligott, 2004). One criterion for enjoyable toys is aimlessness, which gives children freedom of imagination and room for exploration (Ablan, 2019). Children have been observed to enjoy editing and controlling sounds, they particularly like altering their voices and creating their own sound effects through imaginative means

(McElligott, 2004). For instance, scribbling with a pencil slowed down in a recording may sound like a saw cutting wood (McElligott, 2004). As discussed with using sound-augmented toys for peer play, these toys can be used as tools to develop their sound processing abilities by enabling the elicitation of supportive auditory cues, which helps with language ability (Verver, 2020, c).

1.2 DISCUSSION

Participating in Universal Design only when prompted is a flawed path to inclusivity. Designers should be better informed and more equipped to incorporate design details, elements, and functions that directly facilitate an optimized user experience for people with disabilities. ADA requirements exist as a bare minimum baseline for interior and architectural spaces, yet there is no code similar to this as a baseline for general product development. Even if a product that may be optimized for persons with VI does not work for persons with hearing difficulties -- or vice versa -- an object that does not accommodate anyone except those with no particular limitations is always worse. This lack of practiced empathy within the design field must be addressed and efforts to understand different circumstances of disabilities should be increased and encouraged. Persons with VI are not the only demographic that is often excluded from quotidian activities and interactions, but this demographic is still a good place to start. There is a gap between researchers and designers in terms of the application of valuable knowledge to improve VI children's user experience with educational toys. A few of the studies reviewed in this report attempt prototyping solutions, but do not have a team of designers to help produce such innovative tools and toys. Future research should analyze the developmental struggles of other demographics and curate the information gathered for other designers. Commonalities that can make products accessible to larger groups of people should be identified. Future design direction should include an in-depth analysis of current products available on the market, as well as examining the prototypes proposed by researchers.

Good design requires empathy and research of the intended user. Even if one is tasked with designing a toy for the general population of children, universal design is design for all.
Understanding the behaviors of VI children and the impact of the interactions and experiences that face is critical to designing toys that do not stop at just accommodating. Proper stimulation and an understanding of the areas in which VI children struggle should inform the design process. The most important element that should be considered for toy design, educational or leisure, is their enjoyment. Their enjoyment of a toy or tool encourages them to explore new things, learn about novel auditory cues or tactile patterns, and can contribute to preventing a sense of isolation. To obtain the best results, examining each area of early childhood development and focusing on one aspect or a select few can make the most casual of toys a tool for their development and improve their confidence. Design opportunities from this paper include the integration of multi-sensory interfaces and interactions with a focus on tactile feedback, auditory systems with the deliberate intention of helping children understand the spaces they occupy and recognition of sounds, as well as a higher integration of music therapy services into toy design.

2. INTERVIEW

The purpose of this interview is to investigate the impact of sensory experiences that will help design professionals create more inclusive and enjoyable solutions for VI children under the category of toy design. A series of questions were asked to the study participants (Caregivers of VI children). This study would like to 1) understand the status of VI children's play behaviors, 2) find design opportunities, and 3) provide and share criteria for other designers to reference when designing for this demographic.

2.1 METHODOLOGY

A series of semi-structured interviews were conducted online via Zoom and over phone calls. The interviews granted significant responses regarding VI children's interests and areas of improvement in regards to what is available to them. A detailed thematic analysis was conducted to analyze the data and properly paper its findings.

The interview participants were recruited by the following inclusion criteria: 1) Adults that care for a VI child more than 4 times a week, 2) Fluent in English or Spanish. The interview participants were recruited via a recruitment email. Interview questions, such as 1) What activities are they most engaged in/enjoy?, 2) What kinds of activities are they averse to?, 3) When are they most receptive to taking in new information or experiences?, the participants were asked to answer the research questions. The interview plan was reviewed and approved by the Institutional Review Board (IRB) at [University Name Redacted] (IRB protocol number Redacted]).

2.2 RESULTS

Three individuals were recruited for interviews in which two are teachers at a school for the blind, one is a Physical Education (PE) instructor and one a Pre-K teacher, and one is a parent of a low vision and hard of hearing child. The PE instructor made the comment that can be summarized as, "these kids are trying to get feedback from their surroundings to ground them… their other senses are looking for input." The biggest developmental area of concern is related to the children's proprioceptive and vestibular systems. The interview participants mentioned VI children's fear of bumping into things in unfamiliar spaces, the fear of sudden movement, and the general aversion to physical activities and sports. The PE instructor participant noted that Physical Education and exercise is very important because many VI individuals become sedentary and struggle with obesity. Sometimes, according to the Pre-K teacher participant, parents can be too overprotective and stunt the child's gross motor development and hurt their potential for autonomy.

Environment can have an immense impact upon a child's desire to explore space. In an anecdote shared by the PE instructor participant, in one's own home a VI child may be comfortable enough to even run around. The parental participant described their child as very independent and curious unless in a new environment. They described their child's behavior as suddenly very quiet and still. The Pre-K teacher participant explained that safe environments are key to encouraging a child to move and explore. In

unfamiliar environments, VI children tend to remain still and quiet to listen to as much information about the environment around them as they can soak in. This participant mentioned that often VI infants are described as very calm, and this is typically because the infant gets the most input from sounds. The parental participant further discussed how they will hold their child's hand and walk around encouraging them to touch objects and ask questions.

Music was discussed by the parental and PE teacher participants without the need to initiate that discussion. They both conclude that VI children really enjoy music and have observed that it is a great way to encourage them to participate with others. Younger kids like movement activities that are based around music, and some develop the desire to learn various instruments or to sing.

As discussed, sound is a major component to the development of VI children. One participant described how many VI children like the sound of opening and closing doors and drawers, and to transition the child from this activity, they sought out toys with similar sounds like snapping magnetic toys. Other fidget toys with turning and clicks are very popular, as well as "cause and effect" toys which one participant described as "baby play." The participants, who are teachers, would like to see VI kids move on from simpler toys and into more complex toys that involves problem solving, multiple steps, strategy, or pretend play. Toys like the Bop-It and tactile Rubik's cubes are some examples given. More textures and haptic feedback is desired in toys, and actions that require more than one hand or orientation awareness. However, the teacher participants did discuss the issue of tactile defensiveness, which occurs when a child is overwhelmed by the sensory input. Exposing themselves to this input is important so that they can move on to learning braille.

3. DISCUSSION

As discussed in the Literature Review, all the senses and developmental areas are interconnected, but what gives this topic more nuance is that visual impairment does not always exist as its own hurdle. People and VI children typically have other cognitive or physical disabilities as well. Providing criteria and background to help designers produce things specifically designed for the visually impaired will lead to higher levels of social inclusivity and help be preventative of various developmental delays that VI children face due to a lack of proper enrichment in their early childhood.

Based on the interview results, there are several design opportunities that can be explored for VI children. One opportunity is to create toys with more textures and haptic feedback that require more than one hand or orientation awareness. These toys can help improve the children's proprioceptive and vestibular systems, which were identified as areas of concern during the interviews. The design should take into consideration the sensory needs of the VI children to avoid overwhelming them with sensory input, which can result in tactile defensiveness. Additionally, music was identified as an area of interest for VI children, and it was observed that it can be a great way to encourage them to participate with others. Designers can explore toys that combine music with movement activities, and instruments that

are accessible to VI children. Finally, the environment was identified as an important factor in the VI children's desire to explore their surroundings. Designers can explore ways to make unfamiliar environments more accessible to VI children by designing objects that emit sound or have distinctive textures, like floor mats that can indicate boundaries or objects that can guide the children's movement.

4. CONCLUSION

In conclusion, the literature review underscores the importance of providing appropriate toys and tools for VI children to support their early childhood development, improve their confidence and autonomy, and encourage socialization and bonding patterns. While there are several challenges in accessing appropriate toys and tools for VI children, there are also promising solutions, such as the ABBI device, that can help improve VI children's spatial awareness and mobility. It is crucial for researchers, educators, and toy manufacturers to work together to ensure that VI children have access to the same basic experiences of childhood that sighted children have, including enjoying play and learning with educational toys designed specifically for their needs.

The interviews conducted with VI children have shed light on several design opportunities that can improve the children's sensory, social, and environmental experiences. The importance of designing toys with varied textures and haptic feedback that can be explored using more than one hand or orientation awareness was discussed. Such toys could help improve the children's proprioceptive and vestibular systems while taking into consideration their sensory needs.

Furthermore, music has been identified as a potential area of interest for VI children, and designers can explore ways to integrate it with movement activities and make instruments accessible to VI children. The interviews have also emphasized the importance of designing the environment to make it more accessible to VI children. Objects that emit sound or have distinctive textures can guide the children's movement and provide a sense of orientation. It is essential for designers to consider the children's perspectives and incorporate their feedback into the design process to ensure that the toys and tools are appropriate for their unique needs.

Although the sample size of the interviewees was limited, the insights gleaned from the interviews provided valuable knowledge into understanding the issues and potential design opportunities for VI children. Additionally, the author was able to establish connections for this study, which can facilitate the recruitment of more participants for future research, such as surveys and user studies. The findings and discussions presented in this paper will be of significant benefit to designers who are interested in developing multi-sensory toys for VI children.

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Fixed the APA style references. The comment about the letters in the citations for Verver, APA guidelines suggest using a lowercase letter after the year to differentiate them, so I am not sure how to change it from that. Grammar was reexamined and edited. Further development could not be made in time due to collaborations with the school of the blind I

was in contact with, but it will be expanded upon for my thesis. Regarding what can be done with this research, my intent was awareness. There is so much to cover and so much nuance that I do not have a way to package my findings into specific applications. My hope is that by bringing this discussion to more designers, inclusive design can be pushed further into their design goals than they may have been otherwise.