

Understanding the Experience of the Visually Impaired towards a Multi-Sensorial Architectural Design

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Abstract—Visually impaired people, in their daily lives, face struggles and spatial barriers because the built environment is often designed with an extreme focus on the visual element, causing what is called architectural visual bias or oculo-centrism. The aim of the study is to holistically understand the world of the visually impaired as an attempt to extract the qualities of space that accommodate their needs, and to show the importance of multi-sensory, holistic designs for the blind. Within the framework of existential phenomenology, common themes are reached through "intersubjectivity": experience descriptions by blind people and blind architects, observation of how blind children learn to perceive their surrounding environment, and a personal lived blind-folded experience are analyzed. The extracted themes show how visually impaired people filter out and prioritize tactile (active, passive and dynamic touch), acoustic and olfactory spatial qualities respectively, and how this happened during the personal lived blind folded experience. The themes clarify that haptic and aural inclusive designs are essential to create environments suitable for the visually impaired to empower them towards an independent, safe and efficient life.

Keywords—Visually impaired, architecture, multi-sensory design, architectural oculo-centrism.

I. INTRODUCTION

VISUALLY impaired people usually interact with spaces designed from the perception of the sighted, creating a spatial barrier between them and the surrounding environment. This is usually because in a normal spatial perception process, people are more aware of visual information, and it usually prevails over information obtained by the other senses. Consequently, architects and designers tend to focus on the visual sense causing what is called architectural Oculo-centrism [1]. According to the World Health Organization, 285 million people are estimated to be visually impaired worldwide: 39 million are blind and 246 million have low vision [2]. What does it mean to be blind? Medically, visual impairment is defined as "the limitation of actions and functions of the visual system that cannot be corrected using glasses" [3]. Socially, blindness means using the other senses along with alternative skills, methods, and tools to live and interact with the surrounding environment, and perceive the outer world. The World Health Organization

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classified visual acuity and impairment into: moderate visual impairment, low visual acuity, and blindness, [1]; all types of visual impairment are addressed in this paper. The main aim of this paper is to holistically understand the world of the visually impaired, extract the qualities of a space that accommodates their needs, and show the importance of a multi-sensory holistic experience for the blind. This paper also critically condemns the dominance of the visual modality in current architectural practice.

II. UNDERSTANDING THE WORLD OF THE VISUALLY IMPAIRED: THE METHODOLOGY

To holistically understand the world of the visually impaired, an intersubjective approach is adopted that aims at finding common themes from several sources, within the general framework of existential phenomenological research. Intersubjectivity based on finding a shared understanding and agreement. "The skill of constructing a new understanding by combining different perspectives, and this mechanism is stronger when participants have different cognitive levels" [4].

Every method adopted reveals part of the study, it is through the sharing of this body of knowledge that understanding is built. In this paper, the extracted themes are *highlighted in italics*.

Numerous researches aim to explain how the visually impaired perceive their surrounding environment and navigate spaces, some of the best explanations of this experience are narrated by the visually impaired themselves.

This research is based on different sources of blind experiences:

1. Written statements in the literature from an interview with blind architect Downey explaining his experience. Downey is a blind Architect who designs environments suitable for the visually impaired, he lost his sight at age of 45 [5].
2. Written statements from books written by Hull about his blind experience. Hull was Emeritus Professor of Religious Education and is the author of several books in the fields of religious education and disability [6], [7].
3. Semi-structured interview with a formerly blind person (A. A.) in Cairo, Egypt, discussing his experience before recovering from blindness. A. A. is a 24 years old Egyptian who is currently a sighted person who was blind for 18 years.
4. Participant observation in the teaching of visually impaired children in an NGO located in Cairo, Egypt.
 - To understand how visually impaired children are taught to use their senses to perceive the world around them,

participant observation in the teaching classes of visually impaired children during their rehabilitation period (ages one to four) was conducted. The study gives an understanding of how visually impaired children learn about their environment to make up for lost sight. The teaching model adopted by the NGO for the visually impaired children is the Montessori model, developed by Dr. Montessori, “it is a child-centered educational approach based on learning through the senses” [8]. Participant observation with a total number of five children, four hours a day for one month took place. Participating as a tutor allowed the students to act normally as they do every day without the fear of being observed. Table I is a presentation of the participants’ profile.

TABLE I
 VISUALLY IMPAIRED PARTICIPANTS’ PROFILES

Participant's name	Age	Gender	Condition	
P1	Y. B.	3-year-old	female	Congenitally blind
P2	A. A.	4-year-old	Male	Low visual acuity, almost blind
P3	K. A.	2.5-year-old	Male	Congenitally blind
P4	S. A.	4-year-old	Female	Congenitally blind
P5	Y. S.	4-year-old	Female	Low visual acuity, almost blind



Fig. 1 Map showing Weimar City exercise route

5. A personal blind-folded experience simulating the experience of the visually impaired.
 - As a part of achieving intersubjectivity, two exercises were conducted, one in old Cairo, Egypt, and the other was at the Bauhaus University in Weimar, Germany. The aim of the exercises was to understand and perceive the surrounding environment blind-folded, explaining the experience without vision. Although Hull warned “Always remember, just closing your eyes does not give a true impression of a blind person’s experience, because you will still have a seeing person’s brain behind those

closed eyes” [6, p. 24], still this experience on a personal level allowed to get an understanding of the visually impaired world.

- Old Cairo exercise: The blind-folded sound-walk, a four-hour walk carried out in Old Cairo, under the supervision of Dr. Thibaud, Dr. Siret and Dr. Delas, at Ain Shams University.
- Bauhaus university exercises: The exercises were carried out in Weimar city, Germany. It was divided into: 1. Indoor exercises in the main Bauhaus University building (destination 1) and 2. Outdoor exercises walking in Weimar city (destination 2 and destination 3) (Fig. 1).

III. ANALYSIS

From the previously mentioned studies, common themes were extracted from the repeated phrases and meanings.

A. Nature: The Finest Medium between Human Body and Surroundings

The sun, water and air were repeated throughout the study. Downey, in his interview [5], mentioned that he prefers to spend more time outside:

“The outside is so much more dynamic. There are breezes, there are the sounds of a breeze through the leaves in the tree, or birds off in the distance. I spend a lot of time on the front porch of our house, enjoying the street life and all the sounds. There’s a dynamic to the environment outside that is often excluded from the interior.”

In the interview with A. A., he also referred to nature as the finest medium between him and his surrounding space:

“Being totally blind, the only way that I could feel the light intensity in a space was feeling the sun heat on my skin, the sun heat and air flow approach me, made me understand the atmosphere surrounding me, effortlessly”.

Hull in his book “On Site and Insight: A Journey into the World of Blindness”, described a scene when he stepped outside and it was raining, he compared opening the door on a rainy day to a sighted person opening the curtains to see the world outside.

“Rain is considered a colored blanket that throws over previously invisible things, creating a continuous acoustic experience. Through the sound of splashing rain, I can interpret the contours of the lawn, which rises to the right in a little hill. The sound of the rain is different and shapes out the hill curvature for me, if only rain could fall inside a room, it would help me to understand where things are in that room, to give a sense of being in the room, instead of just sitting on a chair” [7, p.22].

While at the park walk in the outdoor exercise at Weimar city, participants mentioned that:

“Entering the park from the main street and feeling the sudden calmness, only hearing birds, water stream, air penetrating through grass and leaves while smelling plants and water. The sunlight warmth was the way we recognized the tree shaded areas, the smell of greens,

flowers and water was strong, felt like the smell of freshness. The special smell of water stream blending in with the soil and rocks, splashing on the rocks then to our skin felt like a way of blending in with the natural elements in the park”.

It was stimulating to the touching sense, that participants approached the water stream, to feel the water running through their fingers (Fig. 2).



Fig. 2 Blending in with nature at Ilm Park

Studies about visually impaired children recommend engagement with nature as a helpful tool in their learning development, and that is why, at the NGO they always create time for outdoor activities once a week.

B. Feeling Materials

“Materials are felt” as mentioned by Downey and A. A. They are heard and felt through touching, tapping and listening to their echoes. Hull mentioned that in his book “On Site and Insight: A Journey into the World of Blindness” when he described how the rain falling and splashing on different materials feels:

“Here, the rain is striking the concrete, here it is splashing into the shallow pools which have already formed. The sound on the path is quite different from the sound of the rain drumming into the lawn on the right, and this is different again from the blanketed, heavy, sodden feel of the large bush on the left. Further out, the sounds are less detailed. I can hear the rain falling on the road, and the swish of the cars that pass up and down” [7, p.23].

When A.A. was asked in the interview about how he used to ride the underground independently, he replied that the difference in floor pavers used in the underground helped him understand the location he was standing on, which made it easy for him to understand his location and orientation.

In the blind-folded exercise, while walking inside the University building and going down the stairs, it had two different handrails, the main one felt warm with an old wood smell, and the other one was cool made of metal and covered in plaster and paint. The smell of the staircase made of old-wood was dominant while During the Sound-walk exercise in Old Cairo, the participants focused on the floor textures under their feet and how it changes the perception when it changes. Rough pavers were harder to walk on, so after a while they had to sit and rest from walking. Materials were also recognized through their smell, participants recognized the

smell of stone from old buildings while walking next to them from and the scent of water reacting with the stones of buildings and with the ground concrete pavers. Also, during the exercise at Weimar city, floor textures were first recognized in the indoor exercise, moving from the classroom to the corridor, then to the main hall, the floor feeling changed from rough concrete to carpet to smooth flooring. At the outdoor exercise, participants mentioned that:

“The contrast between the rough asphalt and the smooth lawn was very recognized, then again from the smooth lawn to the concrete pavers at the city center”.

Visually impaired children are trained to use their feet to feel floor materials under them, sometimes they tend to stretch their legs to be able to identify objects on the floor and to feel the different textures to know the exact location they are standing on, especially if they are not near walls, and this is one of the Montessori activities practiced by the children in the NGO. They also learn to identify different materials through a Montessori activity where they use duplicates of wood, metal, plastic and concrete, recognizing them from their texture, temperature and weight, and matching the same materials together. In this activity, the children learn the materials names as well with the help of the teachers; they keep touching, carrying the materials, matching them and finally naming them. One of the children recognized metal by asking about the “cold, smooth and heavy” material, comparing it to wood, which she thought was “rough, warm and light”.

C. Understanding Spaces

When Downey was asked about a memorable experience for him, he replied that it was at the Kimbell Art Museum designed by Kahn:

“My first experience was going there without sight, and some things didn’t quite come together, like the acoustics. I really wanted to hear what the vaults were like, and see if I could understand the form of those spaces through sound. And I couldn’t; it was just completely dead...I was going all over trying to explore the architecture, tapping my cane, clapping my hands, snapping my fingers...Then at one point, I turned off the side of one of the galleries and into the long exterior vault. As soon as I opened the door and my cane hit the concrete floor, I could hear the architecture. I could hear the whole length extend out in either direction. I could also hear the delicate, crisp sound of people walking on crushed gravel pathways nearby and the sound of a fountain. It was hard to resist. You just wanted to go there, because it sounded like such a delightful space” [5].

Hearing architecture is how he imagined and understood the space, it is how he imagined the height because hearing is the sense of distance, unlike touching. It also helps the visually impaired identify their location and orientation.

When A.A. was asked in the interview about how he was able to recognize how wide a space is without having a walk inside?” Yes, he replied that:

“Echo used to play a very important role in understanding the surrounding space, it made me understand the space wideness and how crowded it is, *high echo means a space is wide and empty and vice versa. I usually prefer ceilings with intermediate heights, low ceilings result in high echoes, while high ceilings make it hard to track echo*”

Downey also said that a place without echoes is a dead place for him.

“Earlier this week, I traveled through some airports that are carpeted everywhere. It was dead and flat. You never *heard footfalls or roller bags*, you didn’t hear the liveliness of the space. I think there are some great airport concourses, where there’s excitement in the space. It’s because you *can hear the sound of travel, the sound of people moving around*” [5].

In the interview with A. A., he mentioned that about understanding the space around him:

“To be able to identify and understand a place, I walk around, touch the surroundings with my cane, hands and feet, hit several objects while walking, clap to feel the echo, and thus, the wideness of space, and I smell the materials and this is how I develop a mental map of the surroundings, making it easier to understand the place when revisited.”

In the exercise of old Cairo, the participants’ impressions involved the width of streets, moving from the main street to narrow alleys, *the sound echo was higher, this helped in understanding how wide the street was*, and some participants recognized the street due to its aural experience only. The scent along the walk was important as *participants remembered specific areas through the smell of perfumes, incenses, bakeries and coffee*. They also noted that it was very important to *touch the surrounding walls to be able to identify the location and buildings* like El Hakim historic mosque and old houses were identified through both cognitive mapping and touching.

During the indoor exercise at the Bauhaus University, the sunlight penetrating through the windows was felt on our skin and its warmth made it easy to indicate the locations of windows without approaching and touching them. Moreover, the airflow felt higher when approaching the double-heighted staircase area and moving towards the main entrance where the door opens and closes.

Visually impaired children learn to use their senses to identify the spaces around them. One of the activities is called “way finding” in which children create a virtual personal space around them with their arms, this space creates a barrier between them and objects around them, then, *arms and feet are used to recognize walls, doors, chairs, table and all other objects*. Another activity involves learning how to identify and avoid obstacles while walking, and this is achieved by *touching an obstructing rope and reacting to it* (Fig. 3). It is one of the hardest activities, as mentioned by the shadow teacher R. A., because the children feel that they can fall anytime when reaching the rope becomes harder, “it’s like taking a walk in new, unrecognized spaces with unknown

obstacles”.

D. Feeling the Attributes and Properties of Objects

When A. A. was asked “How different the things you imagined were after your surgery, he replied that, “It was not different, it was the same but with colors”. Everything that he imagined became almost as it is.

“When I opened my eyes, and started seeing, I was amazed with colors, and ceilings, basically anything my hands couldn’t reach. *I could feel the attributes of any object by touching and feeling it*. When I saw the table, *I knew that this was a table because I remember touching and feeling it*, just like seeing it”.

Stereognosis is developed to train visually impaired children to perceive the size and shape of objects through their hands. One of the activities of form understanding is through play dough (Fig. 4). In this activity, *children shape the play dough into spheres, cubes and rods*. Once they form the shape, *they touch it and name it*; this activity assures the object’s name.



Fig. 3 Obstacles finding and avoiding Montessori activity



Fig. 4 Play dough Montessori activity

“The children learn to understand that there are different forms of objects, like all children do, but unlike the other children who can simply see and learn the different forms, *visually impaired children touch and feel the objects to be able to recognize them*. They also need to learn that there is something called *size and scale*, what is it like to arrange from big to small or vice versa to have a full understanding of what sizes mean. We also train children to *recognize different weights*.” R. A., Shadow teacher.

Another stereognosis activity is arranging forms on a rod, where they alternate several spheres and cubes. The activity usually involves *holding the spheres and inserting them correctly* in the rod filling each rod with the correct number of spheres (Fig. 5). It is a way to understand the different forms

and activate the tactile sense. Moreover, visually impaired children learn about scale and proportion by touching rods of different scales and arranging them from longest to shortest (Fig. 6).

Another activity for scale and proportion is about arranging rings, the children *arrange rings based on their size from the biggest to the smallest* (Fig. 7).



Fig. 5 Forms on a rod activity



Fig. 6 Scale and proportion Montessori activity



Fig. 7 Rings arrangement activity

IV. CONCLUSION

The highlighted phrases indicated emergent themes common from the different adopted methods; Table II shows the themes, sub-themes and through which perceptual channel they reach the human body (other than the visual perception).

TABLE II
 STUDY EXTRACTED THEMES

Themes	Sub-themes	Perceptual channel		
		Haptic perception	Auditory perception	Olfactory perception
<i>Interaction with nature</i>	Airflow	√	√	
	Sunlight heat sensation	√		
	Smell of natural elements			√
	Atmosphere and activities		√	√
<i>Materials texture</i>	Material Roughness and smoothness	√		
	Material Temperature	√		
<i>Materials recognition</i>		√	√	√
<i>Form recognition</i>	Touch and feel recognition	√		
<i>Understanding the space</i>	Ground Topography and contours	√		
	Width and height		√	
	Spatial properties	√	√	√
<i>Spatial recognition</i>		√	√	√

A. Haptic Perception

Haptic feedback is one of the main channels through which the visually impaired perceive their surrounding environment. Through the touching sense, visually impaired people can feel the nature surrounding them, feel the space surrounding them, recognize space and recognize materials. The feedback process starts with sensation and then perception, “The sensation refers to the first stages in the functioning of the senses, related to the effect of a physical stimulus on touch receptors in the skin and their transduction from the

peripheral nervous system to the sensory areas of the brain; perception refers to later stages where the sensation is processed, organized and interpreted so that the organism may use the information to guide its behavior based on understanding its environment” [9].

The extracted themes suggest that the haptic feedback is divided into active and passive touching (Fig. 8).

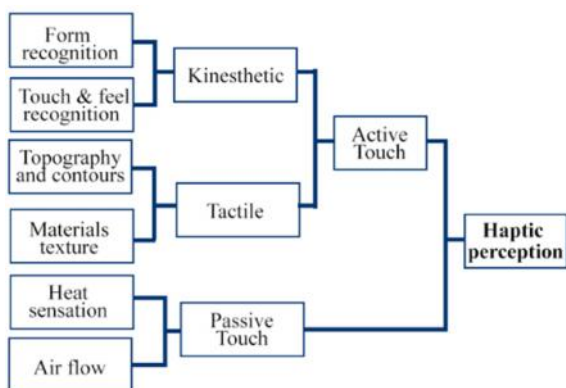


Fig. 8 Haptic feedback

Active touching is when the person interacts while touching and can control his/her sense by moving, exerting pressure, pushing and pulling...etc. Materials texture identification and feeling, perceiving the contours of the ground underneath were considered active tactile stimulants. Kinesthetic involves work with muscles and joints along with the touching; form recognition, touching and feeling the parameters of an object were considered forms of kinesthetic active touching, the way visually impaired children learn form generation and identification is one of the kinesthetic active touching stimulants. Through active touching, visually impaired people select and refine the sensations to give the appropriate perceptual information of their surrounding environment.

Passive touching happens when a tactile event occurs that is unexpectedly reaching the body. The interaction of body with the surrounding nature was considered a kind of passive touching, heat sensation on the skin when the visually impaired feel the light intensity, feeling the nature surrounding, air flow on the skin along with natural splashing water.

Architect Downey uses a tactile palette in his designs and not just a color palette; he mentioned that when designing a visual border, it should be tactile as well. A contrast between two materials should be clear in its texture [5].

B. Auditory Perception

Hearing is crucial for the visually impaired to perceive and understand their surrounding world, it provides a three-dimensional distant and near atmosphere. Fig. 9 shows the auditory perception extracted themes.

The sound of nature is usually preferred to by the visually impaired because it makes them blend with the surrounding environment, the acoustic experience of rain can make a person mentally understand the surrounding environment.

The term “dynamic place” was mentioned by Chris Downey while describing a place with sounds of activity, unlike “carpeted places” where he does not hear the liveliness of the place, and so he described it as dead.

Sound echo also helps in materials and spatial recognition and this is one of the reasons why Downey uses the sound of materials while designing:

“I test materials with my cane to see how they feel.

Instead of doing a ‘walk-through,’ we create a ‘tap-through,’ so you hear what it’s like when you tap your cane throughout the building.”

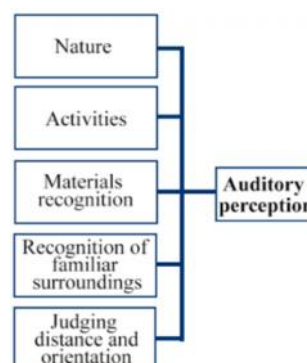


Fig. 9 Auditory perception themes

C. Olfactory Perception

The study shows that sense of smell helps visually impaired people build a mental representation of their surrounding environment. One of the most remarkable things concluded about the sense of smell is how it is related to emotions and memory. Fig. 10 shows the extracted themes related to the sense of smell.

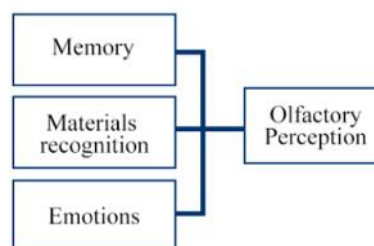


Fig. 10 Olfactory perception themes

Places were easily identified with smell because every place has a certain smell that can be recalled when revisited, moreover, materials are identified from their smell, the smell of wood was easily distinguished, the smell of plaster and paint, damp concrete, and moreover, the age of material was recognized.

D. Cognitive Mapping

For successful orientation and mobility of the visually impaired, a harmony between haptic, auditory and olfactory perceptions is achieved and that is how they easily recognize familiar environments, the senses synchronization.

The process of spatial mental mapping is defined by the following four basic stages [10]:

1. Obtaining information through the senses.
2. Selection and conscious processing.
3. Storage in the form of spatial representation.
4. Decision making, movement and orientation based on the stored representation.

Targeted training of spatial mental mapping for the visually impaired has theoretical as well as practical reasons, and that

is why visually impaired children learn to enhance their cognitive mapping skills by using all their senses to be able to move safely and independently.

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